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Digital Innovation:

People, Practices, Tools.

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Raffaele Fabio Ciriello
from Italy

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Prof. Dr. Gerhard Schwabe
Prof. Dr. Jens Dibbern

The Faculty of Economics, Business Administration and Information Technology of the University of Zurich herewith permits the publication of the aforementioned dissertation without expressing any opinion on the views contained therein.

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Abstract

Fostering innovation is essential to thrive and survive in the software industry. While the existing scientific literature widely assumes that companies can foster innovation by means of a centrally planned, top-down specified innovation process, little is known about the actual practices of innovative employees. This dissertation offers a distinct, practice-based perspective on digital innovation that emphasizes its bottom-up emerging character. Understanding digital innovation as a practice implies a paradigm shift from managing and controlling innovation processes to enabling and facilitating employee-driven innovation practices. The practice-based perspective is grounded in empirical insights from an in-depth qualitative case study at two software companies. By analyzing the important role of artifacts and social interaction in parallel, this dissertation contributes to a better understanding of digital innovation practices. Moreover, it presents tools to enable digital innovation practices by providing starting points to support employee-driven innovation with information systems.

Keywords: Digital Innovation Practices, Innovation Artifact, Social Networking, Information Systems

Zusammenfassung

Innovation ist für Firmen von fundamentaler Bedeutung um in der dynamischen und sich konstant verändernden Softwareindustrie kompetitive Vorteile zu erlangen und zu erhalten. In der bestehenden wissenschaftlichen Literatur wird weitestgehend davon ausgegangen, dass Firmen Innovationen durch einen zentral geplanten, von "top-down" spezifizierten Innovationsprozess steuern können. Jedoch ist bisher wenig über die tatsächlichen Praktiken innovativer Mitarbeiter bekannt. Diese Dissertation schafft eine andere, Praktiken-basierte Perspektive auf digitale Innovationen, die deren von "bottom-up" entstehenden Charakter unterstreicht. Digitale Innovation als eine Praktik zu verstehen impliziert einen Paradigmenwechsel von der Verwaltung und Steuerung von Innovationsprozessen hin zum Ermöglichen und Unterstützen von mitarbeitergetriebenen Innovationspraktiken. Die Praktiken-basierte Perspektive stützt sich auf empirische Einblicke einer eingehenden qualitativen Fallstudie in zwei Softwareunternehmen. Durch eine parallele Analyse der zentralen Rolle von Artefakten und sozialen Interaktionen leistet diese Dissertation einen Beitrag zu einem tieferen Verständnis von digitalen Innovationspraktiken. Darüber hinaus präsentiert sie Werkzeuge um digitale Innovationspraktiken in Firmen zu ermöglichen, indem Ansatzpunkte geliefert werden, mitarbeitergetriebene Innovation mit Informationssystemen zu unterstützen.

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1 Synopsis

1.1 Introduction

Innovation is essential to thrive and survive in a competitive market (Tidd and Bessant, 2011). This forces companies to support employees-driven ideas (Desouza, 2011), open up towards internal and external collaborators (Chesbrough, 2003, p. 2), and keep pace with rapidly evolving digital technologies (Yoo et al., 2012). According to the process-based models that prevail in the existing literature, innovation is seen as a discrete, linear, and sequential process with clearly ordered, differentiated, and consecutive phases (Chesbrough, 2003; Desouza, 2011; Fichman et al., 2014). Process-based models are largely limited to top-down specified innovations that follow a linear path, without embracing the often-serendipitous entrepreneurial practices of those people who actually innovate, and without further differentiating between characteristics of digital and traditional innovations. The goal of this dissertation is to offer a distinct, practice-based perspective on digital innovation by providing empirical insights from an in-depth qualitative-interpretive case study in two software companies.

The main contribution of this dissertation is an empirically grounded conceptualization of digital innovation practices. Through multiple in-depth analyses of the role of artifacts and social interactions, this dissertation provides a deeper understanding of digital innovation practices in software companies. Building on this understanding, it also offers a set of tools to support these practices. This has far-reaching implications for digital innovation researchers and practitioners, as it suggests a broader shift in perspective from managing and controlling top-down specified innovation processes toward facilitating and enabling bottom-up emerging innovation practices. More specifically, the contributions of this dissertation can be grouped into three parts:

1) By analyzing the role of artifacts, this dissertation specifies a set of digital innovation practices. The analysis shows that artifacts play a central role in supporting digital innovation practices, such as making sense of ideas, aligning mental models, negotiating solution paths, and crafting ideas. This informs future studies on the design and use of artifacts that support digital innovation practices by helping researchers to understand the appropriateness of artifacts in different contexts.

2) By analyzing social interactions, this dissertation specifies a set of factors that influence the development of innovative ideas in social interaction. The analysis shows

that material infrastructure, personal characteristics, and innovation process phases play an important role in supporting collective creativity, which is an important driver of digital innovation practices. This informs future studies on the support of social interaction in organizations about the bottom-up emergent nature of digital innovation practices, how these are enacted in the interactions between people, and how the organizational environment influences the nature of these interactions.

3) Based on the insights obtained from the above two analyses, this dissertation offers tools for enabling digital innovation practices in organizations. This informs future studies on innovation management by providing structured guidance how innovators can communicate ideas purposefully with artifacts. Moreover, it develops an idea screening framework that facilitates the evaluation, selection, and tracking of employee-driven ideas. These tools can be implemented in small and medium-sized enterprises to support innovation practices.

This dissertation's research approach is as follows. Through multiple case studies conducted over a period of more than two years at two software companies, I could study and participate in practices related to the development of innovative software products. Thereby, I obtained a deep practical understanding of the problems innovators face (Walsham, 1995a, 2006). By gathering and analyzing an extensive data set, consisting of in total 95 semi-structured interviews, 480 artifacts and digital documents, and 214 days of participant observations, the need to address digital innovation from a practice perspective emerged to better understand and conceptualize the way people innovate with and toward digital technologies. I mainly draw on qualitative methods to conceptualize digital innovation practices, but also on design science methods to develop tools.

The structure of this dissertation is as follows. Section 1.2 starts with defining the key concepts and describing the research gap and research questions that this dissertation addresses. I then present the research approach of this dissertation and give detailed insights into the case studies in section 1.3. Section 1.4 continues with explaining the contributions of this dissertation by illustrating an overview of the papers therein and summarizing their most interesting findings, along with explaining how they relate to each other. Section 1.5 then summarizes the key takeaways of this dissertation and answers the research questions explicitly. Finally, section 1.6 points to areas of future work that could build on this dissertation and discusses its limitations. The chapters that follow this synopsis contain the seven papers that constitute this cumulative dissertation. As often with cumulative dissertations, this

synopsis is partly redundant with the papers in chapters that draw on the same foundation (e.g. literature, methodology).

1.2 Definitions, Research Gap, and Research Questions

This section reviews existing literature to identify the research gap. Based on this, it also delineates the guiding research questions. The aim is essentially to clarify the basic concepts that are used throughout the dissertation, thereby helping the reader to assess its value, understand how its single parts fit together, and how it draws on key concepts that build on each other. Specifically, four concepts will appear coherently throughout this dissertation: *1) Digital innovation 2) Practices, 3) Artifacts, 4) Social interaction*. It should be noted that there are currently no consistently agreed upon definitions for any of these concepts in the scientific community. While digital innovation is a rather new term that only recently attracted the interest of the information systems (IS) community, the concept of practice has different scholarly traditions behind it, each of them with in part very different understandings. The situation is similar for the terms artifact and social interaction. Achieving universally applicable definitions for these concepts would thus go beyond the goal of this dissertation. I will rather, more modestly, provide a clarification of how they are understood in this context. Essentially, this section argues that digital innovation has unique characteristics that differentiate this new phenomenon from traditional innovation and requires a practice turn to be better understood. This is followed by arguing that analyzing artifacts and social interactions facilitates a deeper understanding of digital innovation practices.

Definition: Digital innovation **(based on Fichman et al., 2014; Rogers, 2010; Yoo et al., 2010)**

Digital innovation is a practice that involves information technology (IT) both as a means and an end to develop new products.

New Products: This definition emphasizes several important characteristics of digital innovation. It reveals that the focus of this dissertation is on new products. While innovation can be understood more broadly as products, processes, business models (Fichman et al., 2014, p. 330) or even ideas and objects (Rogers, 2010, p. 475), this dissertation chooses a narrower focus on digital product innovation to explore one type of innovation in depth. Another important characteristic here is that the product is new. This distinguishes the use of the term from routine development, because the product must be perceived as new by an adopter or the developing organization to

count as innovation (Fichman et al., 2014; Rogers, 2010). Here, the classifier 'new' comprises both entirely new developments from scratch (also called radical innovation) and substantial extensions, replacements, or refinements of modules as part of existing products (also called incremental innovation) (Desouza, 2011, p. 30).

Involvement of IT: Moreover, this definition emphasizes the involvement of information technology in the development. This is important because information technology has distinctive characteristics that differentiate digital innovation from traditional innovation. Some of these characteristics are, according to Yoo et al. (2010), reprogrammability, homogeneization of data, and self-referentiality. Reprogrammability means that information technology enables devices to perform a variety of functions through a "*separation of the semiotic functional logic of the device from the physical embodiment that executes it*" (p.726). This means that products have no fixed boundaries but can be continuously expanded with multiple new functionalities. Homogenization of data refers to the capability to separate the content from the medium by allowing any digital content (e.g. audio, video, text, and image) to be stored, processed, and displayed (p.726). This means that a digital product can fulfill multiple purposes. And self-reference means that digital technology requires the use of digital technology, which creates positive network externalities and "*fosters further digital innovation through a virtuous cycle of lowered entry barriers, decreased learning costs, and accelerated diffusion rates.*" (p.726). This means products have high scalability and low entry barriers, which allows a variety of people to participate and leads to democratized innovation (Yoo et al., 2010).

IT as means and end: Furthermore, this definition emphasizes the involvement of IT both as a means (i.e. resource, object, equipment) and an end (i.e. outcome, objective, product) of the development, because the distinctive characteristics of IT have different implications for both modes. Using IT as a means of development offers vast possibilities for innovators, for instance by gathering massive amounts of market data with business analytics tools, interacting with potential users over social media, collaborating with partners on a global scale with online collaboration or crowdsourcing platforms, and getting financial resources with crowdfunding platforms. When IT is the outcome of the development, the new product has embedded digital capabilities that allow recombination with other digital and physical artifacts, such as e-readers, smartphones, or smart cars (Yoo et al., 2012). This enables new forms of organizing, such as virtual team work, that emerge from the lower cost of communication and coordination, through which the innovation practices disperse geographically and move towards the periphery of organizations (Yoo et al., 2012).

First Research Gap: Taking the Practice Turn in Digital Innovation

The central point here is that the distinctive characteristics of digital innovation provide an environment of open and flexible affordances, which requires us to rethink existing views about innovation (Yoo et al., 2012). The prevailing view in the existing innovation management literature is a discrete, linear, and sequential innovation process with clearly ordered, differentiated, and consecutive phases. For instance, Tidd and Bessant (2011) divide the innovation process into *search, select, implement*, and *capture*. Chesbrough (2003) differentiates between *research* and *development*. Desouza's (2011) innovation process consists of *idea generation, advocacy & screening, experimentation, commercialization,* and *diffusion & implementation*. And Fichman et al. (2014) distinguish between *discovery, development, diffusion,* and *impact*. What these perspectives have in common is that they are all based on the assumption that the innovation process usually takes a linear path. Repetitions of single phases are a rarely necessary exception. A dogmatic implementation of the linear process perspective would prohibit to skip phases. It would also be impossible to move backwards into the process or to carry out several phases at once. One phase could only start when the previous one is fully completed. However, it throws into question whether this is actually the case with digital innovations, which are characterized by reprogrammability, homogeneization of data, and self-referentiality (Yoo et al., 2010). Can flexible and recombinable digital innovations really be specified clearly, completely, and precisely in advance? Can self-referential and democratized digital innovations really be developed exactly as specified without unanticipated technical or social constraints? And will the end user always refrain from using the malleable digital innovation in unexpected ways, or from not using it at all? The reality looks quite different (Wessel, 2014). The major disadvantage of the strictly sequential approach is that the practical benefit of the innovation can be evaluated at a very late stage only. When companies fail to notice change requests or tacit requirements in time, necessary adjustments can only be accomplished with considerable effort. As a result, a lot of innovation potential may remain unused and the success rate of innovations in the market may remain relatively low. The strict separation of single innovation process phases may therefore be an inadequate idealization in the context of digital innovation. Experience from the field of software engineering has already shown that classical linear product lifecycle models are inadequate for software-intensive product development (Pomberger et al., 1992), leading to an extensive discourse about agile development processes (Highsmith and Cockburn, 2001). This dissertation develops a practice-based model of digital innovation that provides a starting point for managing digital innovation in organizations.

The paper "Understanding Digital Innovation Practices Through Artifacts" (section 2) in this dissertation offers a more detailed argumentation for taking a practice turn in digital innovation.

In essence, this dissertation argues that we can overcome the limitations of process-based views on innovation when we understand digital innovation as a practice. Assuming that industries are stable and develop fixed products in a linear way would limit our understanding of the potential of digital innovation, because with embedded digital capabilities, product boundaries become more dynamic and malleable (Yoo et al., 2012). A practice perspective facilitates focusing on the work and behavioral intentions of innovating persons (Majchrzak et al., 2012), and helps us to see innovation as a continuous, ongoing, and collective accomplishment of something people do and enact (Pantzar and Shove, 2010). For instance, doctors do not only practice medicine, but are doctors *because* they practice medicine, and one can only become a doctor in an already existing practice of medicine (Riemer and Johnston, 2014). Accordingly, as a 'digital innovator', a person is a carrier of the practice of digital innovating. Any innovation process, whether digital or not, can only unfold as a sequence of practices and, therefore, needs to be understood as a practice. The appropriate level of analysis to capture the complexity of digital innovation is, thus, at the level of practice (Tuomi, 2002, p. 19). By making a case for digital innovation practices in two software companies, this dissertation argues for taking a practice turn in digital innovation and, referring to the above-mentioned first research gap, addresses the main research question:

Main Research Question (RQ1)
How do people practice digital innovation in the software industry?

What exactly are practices and how can we as researchers try to better understand them? The answer is not trivial, as there is currently no such thing as a unified practice theory, but rather several different scholarly traditions with quite distinct understandings (Nicolini, 2012, p. 8ff). It is thus necessary to define the term more closely and explain briefly how it is used throughout this dissertation.

Definition: Practice (based on Nicolini, 2012, pp.105-118)
A *practice* is a routinized and interdependent set of goal-oriented, artifact-mediated, and social human activities.
Definition: Artifact (based on Nicolini, 2012, p.105)
An *artifact* is a human-made material device that people use in practice.
Definition: Social Interaction (based on Arnold et al., 1971, p. 216)
Social interaction refers to the mutually related activities of people that act and react to those around them..

Human Activity: This definition incorporates an understanding of practices that follows the traditions of Wittgenstein, Heidegger, and Activity Theory (see Nicolini, 2012, chapters 5 and 7 for an overview). It emphasizes that the central unit of analysis for practices is human activity (Engeström, 1987; Leont'ev, 1978). Practices are carried out by humans who skillfully and purposefully conduct activities using their brains, bodies, and material objects to satisfy their needs and intentions (Kaptelinin and Nardi, 2009). In fact, practices constitute human sociality and being human means first and foremost to carry out practices as a 'doer' within a social context (cf. Nicolini, 2012, pp. 105-118).

Routinized and Interdependent: Routinization and interdependence are defining characteristics of a practice. Through repeated performance, practices are inscribed into what some authors call social memory (Nicolini, 2012, p. 167). This means that people can learn and grow into an existing practice that outlives and exists independently of single individuals (e.g. driving a car). Moreover, practices do not exist as isolated entities but are interdependent, meaning that several practices can be hierarchically nested into each other (e.g. stepping on the clutch pedal, accelerating, operating the indicator), and that one practice can be the input for another one (e.g. getting a driver's license, commuting to work).

Goal-Oriented: The main organizer that binds a system of interdependent practices together is their goal, sometimes also referred to as object (Engeström, 1987). The goal brings different people together to work toward a common purpose, and is thus a source of coherence and energy that motivates people. All practices are goal-oriented and a practice without a goal is simply inconceivable (Nicolini, 2012, p. 95). The goal of a practice can be understood as prospective outcome that motivates and directs

practices, around which practices are coordinated, and in which practices are crystallized when they are completed (Kaptelinin and Nardi, 2009, p. 6).

Artifact-Mediated: The relationship between people and their goal is mediated by artifacts. Through their material characteristics, artifacts set possibilities and constraints to the way people pursue the goal of a practice. Since the output of one practice may become the input of another, artifacts are the outcome of previous work, and when used in a new context, they embody the original work in the new situation (Nicolini, 2012, p.105). Thus, artifacts both make practices durable and connect them across space and time (ibid). For instance, the practice of classroom teaching is both mediated by and depends on a series of artifacts, such as the seats in the classroom, board, clock, pen and paper, etc. (Nicolini, 2012, p.4f). These artifacts are internalized by participating in practices and can fundamentally shape and transform mental functioning (Miettinen and Virkkunen, 2005). What we do and what we use fundamentally influences how we think and how we perceive the world and ourselves (Nicolini, 2012, p.107). Thus, the way in which artifacts are used in practice is crucial for both the definition of their role and function (Levina and Vaast, 2005), and for understanding the practices themselves (Nicolini et al., 2012).

Second Research Gap: The Role of Artifacts in Digital Innovation Practices

The essential point here is that the nature of the practices depends crucially on the mediating artifacts that people use. If we want to understand digital innovation practices, we cannot direct our attention away from the important role of artifacts therein. As Nicolini puts it, when we examine the world in terms of practices, "we cannot avoid taking into consideration the central role of artefacts (...) We cannot make sense of our practices without taking into account the materials that enter it. Objects, materials, and technology need thus to be studied 'in practice' and with reference to the practices in which they are involved." (Nicolini, 2012, p.171). However, innovation plays only a peripheral role in the existing practice literature, and the digital innovation literature, in turn, has overlooked the important role of artifacts (cf. section 2). As a result, the role of artifacts in digital innovation practices remains unclear. Hence, a key idea in this dissertation is that we can understand digital innovation practices better through studying artifacts people use. An artifact lens facilitates uncovering the "process of materialization enfolding in material-discursive practices of IS development, implementation, and use" (Cecez-Kecmanovic et al., 2014, p. 812). For instance, a carpenter who is hammering encounters a hammer as something for doing what carpenters do, namely hammering nails, and for being what carpenters are, namely craftsmen; the hammer draws its role from the carpentry practice, and draws its purpose from the practice it is used for and constitutive of, namely hammering (Riemer and Johnston, 2014). Accordingly, as digital technology exists only as technology-in-use embedded in a specific practice, the researcher may obtain a better understanding of the underlying practices through studying artifacts in use. Not unlike archaeologists, who study ancient cultures through analyzing left material traces, practice theorists argue that we can understand contemporary sociality through the ecology of artifacts that surrounds and shapes our everyday life (Knorr-Cetina, 1997).

The paper "Understanding Digital Innovation Practices Through Artifacts" (section 2) in this dissertation offers a deeper understanding of the role of artifacts in digital innovation practices. In addition, the two papers "PowerPoint Paradoxes in Digital Innovation Practices" (section 3) and "When Prototyping Meets Storytelling" (section 4) in this dissertation offer an in-depth analysis of the role of PowerPoint and prototypes in digital innovation practices, respectively.

Social: A practice is not a one-off moment without a history or future. Practices are always embedded in a historical and social context that gives structure and meaning to what people do (Wenger, 1998, p. 45). In this sense, practices are by definition social, and the sometimes-used term 'social practice' says the same thing twice (Nicolini, 2012, p.227). There is, in fact, no way *not* to be socially situated when carrying out a practice, even in perfect solitude (ibid). Even a lone jogger carries out a practice that has a collective social history (namely jogging), and involving an array of artifacts that embody the history of previous work (e.g. shoes, running clothes, fitness tracker). The jogger is indeed connected to a larger community of joggers by carrying out the practice of jogging, and by incorporating the outcome of the jogging practice (e.g. a healthier cardiovascular system, increased wellbeing, better focus) into other practices (e.g. interacting with peers, writing). Accordingly, the practice of innovating digitally is never carried out by some lone entrepreneur in an isolated quiet chamber, but should rather be seen as a collective and social accomplishment. Creative ideas often do not stem solely from 'eureka' moments of individual cognition, but rather from insights that emerge in social interaction, such as collaborative problem solving or simply talking about ideas. Because practices are always interdependent, creativity occurs as a confluence of ideas from multiple sources (Hargadon and Bechky, 2006, p. 486).

Third Research Gap: The Role of Social Interaction in Digital Innovation Practices

The key argument here is that if we want to understand digital innovation, we need to understand how people collectively develop ideas in social interaction. Ideas lie at the heart of each innovation. Initially, ideas exist only as an abstract conception in someone's mental model, i.e. an intangible and volatile image in the mind of a person (Partridge, 1991, p. 303f). Only when a person communicates an idea, it meets the realm of reality and becomes a germ cell of innovation. Recent studies show that innovators are most capable who when they are well connected and have a strong personal network (Desouza, 2011, p. 72; Graf and Krüger, 2011). However, the role of social interaction in digital innovation practices remains unclear (cf. section 5). Hence, if we want to understand digital innovation practices we need to put a strong focus on the way people interact with each other.

The paper "Idea Hubs as Nexus of Collective Creativity in Digital Innovation" (section 5) in this dissertation provides a more detailed discussion about the need to study the role of social interaction in digital innovation.

The key idea of this dissertation is that digital innovation practices need to be studied by emphasizing the role of artifacts and social interaction in parallel. In IS research, practice-based studies have gone hand in hand with a parallel emphasis on the social and material nature of practices, where the relationship between human activity and information technology is one of mutual mediation (Leonardi, 2011; Orlikowski and Barley, 2001). As Orlikowski (2007)puts it, the practice lens unveils that "materiality is integral to organizing, positing that the social and the material are *constitutively entangled* in everyday life" (p. 1437, italics in original). Practices are thus always social and material (Nicolini, 2012, p.105), and since we have seen that digital innovation should be understood as a practice, we need to emphasize the role of artifacts and social interaction in digital innovation practices together. Studying digital innovation practices from both an artifact perspective and a social interaction perspective not only yields a deeper understanding of digital innovation in general, but also lets both perspectives draw upon each other to their mutual benefit. Firstly, analyzing the role of artifacts in digital innovation practices is necessary to understand how practices are fundamentally shaped and transformed by the mediating artifacts that people use. This means that the artifact perspective allows to draw conclusions about the practices themselves and to understand them better. For instance, a researcher can reconstruct the creative process that underlies an innovation by collecting and analyzing artifacts that people use in various practices. Hence, any innovation management endeavor would benefit from an improved understanding of the important role of artifacts in digital innovation practices. Secondly, the inherently social character of practices implies a need to better understand how ideas are constructed and negotiated in social interaction. This allows the researcher to examine why and how social interactions enable the idea to evolve in the first place. Thus, the main research question can be divided into two specific ones that emphasize the role of artifacts and social interaction respectively, referring to the second and third research gap. Moreover, as outlined in the following sections, the deeper understanding of digital innovation practices that results from studying the role of artifacts and social interaction also offers an opportunity to provide actionable guidance for practitioners. Hence, a third specific research question can be derived that focuses on designing solution approaches for enabling digital innovation practices in organizations.

Specific Research Questions

RQ1.1 - What role do artifacts play in digital innovation practices?

RQ1.2 - What role does social interaction play in digital innovation practices?

RQ1.3 - How can organizations enable digital innovation practices?

1.3 Research Approach

This section details the research approach of this dissertation. Since the goal is to understand digital innovation practices from a participant's perspective, I conducted qualitative-interpretive field studies (Klein and Myers, 1999; Walsham, 1995a, 2006). Figure 1 illustrates the overall research approach and the following sections explain the singe activities in further detail.

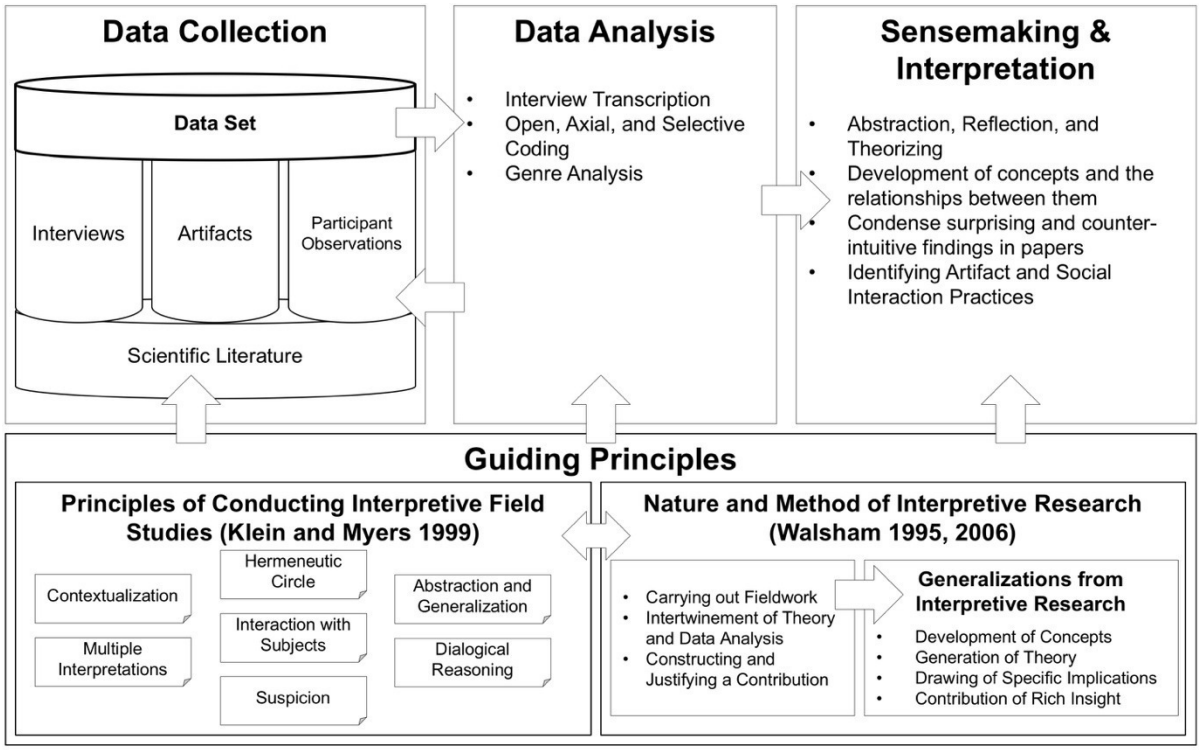

Figure 1-1 : Overview of Research Approach

The study of practices always starts in the middle of action. The practice researcher needs to start the investigation by zooming in on practices, directing attention to what people are doing and saying (Nicolini, 2012, p.211). The basic move here is to follow people, artifacts, and interactions wherever they go (ibid, p.231). Over the course of almost three years, from 2013 – 2015, I could zoom in and out iteratively (Nicolini, 2009) on the actual innovation practices at two companies, beginning as an intensive case study in one location and then expanding to another location by following

emerging relations, while playing with multiple theoretical lenses when interpreting them (Walsham, 2006). On several levels of detail, I defined studies and sub-studies, using the results of one study to feed the next (sub-)study. The transferability of the findings was established through concatenation - the accumulation of studies from which inductions may be made (Lofland, 1976), and through which inter-subjective concurrence on inductions may be established (Popper, 2014). This allowed me to examine the actual digital innovation practices of the case companies in detail, through which I could generate rich insights into them by merging multiple theoretical perspectives, and, conversely, testing whether existing theory helped to make sense of the empirics.

1.3.1 Guiding Principles of Interpretive Research

This section summarizes the guiding principles that underpin the interpretive research tradition, and explains how I applied these throughout this dissertation. While the development of the interpretive tradition has been subject of extensive academic debate (see Walsham, 1995b for a detailed discussion), Interpretivism is today a well-accepted school of thought in IS research (Orlikowski and Baroudi, 1991; Sarker et al., 2013; Walsham, 1995a). It takes an ontological and epistemological stance in which facts and values are intertwined ingredients of scientific knowledge, and 'reality-for-us' is an inter-subjective social construction of the shared human cognitive apparatus (Walsham, 1995a, p. 76).

The in-depth qualitative case study is a common vehicle for interpretive field research. Walsham (2006, 1995a) discusses some philosophical, theoretical, and methodological issues of conducting interpretive case studies in IS research, and urges researchers to sensitivity of the critical role of theory. Following the widely acknowledged distinction by Eisenhardt (1989), this author argues that theory can be used as initial guide to research design and data collection, as part of an iterative data collection and analysis process, or as final product of the research. He further identifies four types of possible generalizations from interpretive case studies: 1) development of concepts, 2) generation of theory, 3) drawing of specific implications, and 4) contribution of rich insight. Interpretivism sets high standards for constructing and justifying a contribution on relevant topics through rigorous research (Walsham, 2006). Thus, I followed the guidelines by Klein and Myers (1999, p. 72) who identify the following set of seven principles for conducting interpretive field research. Table 1 summarizes how I applied these principles in this dissertation, and the following paragraph provides further explanations.

Table 1-1 : Principles for Conducting Interpretive Field Research (after Klein and Myers 1999) and their Application throughout this Dissertation

Principle	Application of Principle throughout this Dissertation
1: Hermeneutic Circle	Collecting data from multiple sources, obtaining long-term in-depth access to multiple interpretations of the focal phenomenon.
2: Contextualization	Each paper in this dissertation includes a detailed presentation of the case and provides context of the specific inquiry.
3: Interaction between Researcher and Subjects	Transparent explanation of methodology and its applications (e.g. conducted interviews, workshops, participant observations, informal contact) in respective sections of the dissertation and papers.
4: Abstraction and Generalization	Playing with multiple theories, linking findings to existing theories, and developing new concepts where theories lack.
5: Dialogical Reasoning	Iterative refinement, concatenation of multiple sub-studies at various levels of detail. Presentation of research findings to scholarly audiences at conferences, workshops, and symposia.
6: Multiple Interpretations	Large sample of participants with in total 95 interviews, 480 artifacts, and 214 days of participant observations.
7: Suspicion	Examining and contrasting multiple sources of evidence (interviews, artifacts, observations), critical reflection, discussion of the findings with practitioners in workshops and focus groups.

1) *The Fundamental Principle of the Hermeneutic Circle* asserts that all human understanding is achieved by iterations between the interdependent meaning of parts and the whole that they form. Through multiple of these iterations, a shared meaning of a larger whole emerges. This principle is a meta-principle that underpins the following six principles.
2) *The Principle of Contextualization* asserts that interpretive research requires critical and explicit reflection of the social and historical background of the research setting to allow the intended audience to understand how the observed phenomenon emerged. This is necessary to overcome the inherent distance between the author and the reader of a text.
3) *The Principle of Interaction between the Researchers and the Subjects* asserts that interpretive research requires critical and explicit reflection on how empirical data

was constructed in social interactions between the researchers and participants. The interpretive research tradition does not see truth to be objectively given "out there", but rather as intersubjective social construction. The participants, just as the researchers, are interpreters who appropriate the concepts used by researchers interacting with them.

4) *The Principle of Abstraction and Generalization* asserts that interpretive research requires relating the details of the data interpretation to general concepts that describe the nature of human understanding and social action. The detailed documentation of unique circumstances that results from interpretive research does not exclude relating these details to theoretical abstractions and generalizations. Theoretical implications distinguish interpretive research from just anecdotes.
5) *The Principle of Dialogical Reasoning* asserts that interpretive research requires sensitivity to contradictions between theoretical lenses and actual data. Researchers should be aware of and explicit about the philosophical assumptions and "prejudices" that underpin their research, and look for surprising, counter-intuitive findings that require subsequent cycles of revision.
6) *The Principle of Multiple Interpretations* asserts that interpretive research requires sensitivity to differences in interpretations among the participants. Human practices are conditioned by a social context involving multiple agents. Seeking out and documenting multiple viewpoints allows examining the influence of the social context on the practices under study.
7) *The Principle of Suspicion* asserts that interpretive research requires sensitivity to possible biases and systematic distortions in the narratives collected from the participants. What participants actually do may be different from what they say they do, simply because they carry out some actions subconsciously.

1.3.2 Case Data Collection

As typical for interpretive research, I used an iterative approach to data collection and analysis until a coherent picture emerged, moving back and forth between theories and the different interpretations of the case study material I obtained from social constructions such as language, shared meaning, documents, tools, and other artifacts (Klein and Myers 1999). Data collection followed the principle of triangulation (Silverman, 2006, p. 291) where I examined the research issue from different sides, compiling multiple interpretations obtained from interviews, observations, field notes, and documentary material into a coherent picture (Klein and Myers, 1999). I had an

opportunity to study digital innovation practices in two software companies, here termed BITS and CustomSoft. Further relevant information about the case companies can be found in the respective papers. The company names are anonymous for privacy considerations. Table 2 provides an overview of all collected data, and the following provides an overview of how it was collected.

Table 1-2 - Overview of Collected Data

Data Source	Interviews	Artifacts	Participant Observation
Total Amount	95 Interviews - BITS: 62 participants - CustomSoft: 33 participants Word Count: 612,401 Length - total=5677 minutes - average=59.76 minutes - minimum=19 minutes - maximum=104minutes	480 artifacts - BITS: 418 artifacts - CustomSoft: 62 artifacts e.g. handwritten sketches, UI mockups, usage descriptions, PowerPoint decks, diagrams, text documents, prototypes	214 days - BITS: 196 days - CustomSoft: 18 days Passive: workplace observations, meeting attendance, and informal contacts Active: talks, workshops, steering meetings, collaborations

The style of involvement with BITS was that of a closely involved researcher having in-depth access to data, issues, and people, who was viewed as one of 'them', making a valid contribution to the field site (Walsham 2006). The style of involvement with CustomSoft was that of an outside observer who was not seen as having a direct personal stake in various interpretations at outcomes, with personnel being relatively frank in expressing their views (Walsham 2006). In all, I conducted and recorded 95 semi-structured interviews ranging from 19 to 104 minutes' duration with experts involved in innovation projects at BITS and CustomSoft. By interviewing such a wide range of participants with differing roles and from different units I could seek out and document multiple interpretations of the actions under study (Klein and Myers, 1999, p. 77). I recorded and transcribed all but two interviews to capture a full description of what was said and facilitate later in-depth analysis (Weston et al., 2001). I wrote up detailed interview notes within a day to capture ideas and experiences that emerged during the interviews or events thereafter, and to share these thoughts with fellow researchers. Through these recorded interviews, it was possible for me to step back and access the interpretations of the fellow participants in more detail (Walsham, 1995a). Further information about how I conducted the interviews can be found in the respective papers of this dissertation. During these interviews, the respondents typically described common practices around concrete artifacts, of which I collected in total 480 artifacts (418 at BITS, 62 at CustomSoft) from respondents or intranet

platforms. I later analyzed a subset of these artifacts in more detail, as described in more detail in the respective papers. In addition, the companies provided me with office access and desk infrastructure through which I could conduct a series of participant observations at formal gatherings (meetings, workshops, presentations and fairs) and informal gatherings (lunches, impromptu meetings) in the context of the innovation projects. Where possible, photographs and field reports complemented the observations.

1.3.3 Case Data Analysis

In analyzing the case data, I applied the principle of the hermeneutic circle, which suggests that "we come to understand a complex whole from preconceptions about the meanings of its parts and their interrelationships" (Klein and Myers, 1999, p. 71). As typical for interpretive research, I inductively generated shared meaning from the collected data through iterative cycles of qualitative data analyses, interactions with participants, and interactions with other researchers sharing similar interests and expertise (Walsham, 1995a). At first, I met in weekly focus groups with other involved researchers from the University of Zurich to maintain a critical distance with the views of people in the case companies, moving back and forth between data and theories, interrogating field material to check whether the data supported emerging claims and, conversely, whether theories helped us making sense of the empirics (Walsham, 2006; Yanow and Schwartz-Shea, 2006), such as field reports, interview excerpts, and artifacts.

We then cross checked the transcriptions among the research team and imported them in MAXQDA to facilitate in-depth analysis and increase confidence in the findings (DeCuir-Gunby et al., 2011). In close collaboration with one other researcher, I broke down the interview data analytically using open coding to identify interesting topics and axial coding to identify relationships between these (Corbin and Strauss, 1990). Two additional researchers then carried out coding checks to increase intercoder reliability and develop a shared conception of reflection (Weston et al., 2001). In our following analyses, we elaborated the codebook in the weekly focus groups to identify themes from various interviews and derive new codes in vivo from the data (DeCuir-Gunby et al., 2011), using selective coding techniques to identify the main phenomenon of interest (Corbin and Strauss, 1990). More detailed information about the coding process are in the respective papers of this dissertation.

1.3.4 Structured Literature Analysis

From the start and throughout this research project, I conducted a structured literature analysis to elicit the current state of research in the field and to position my work in a larger discourse. I followed the well-established literature research framework by Vom Brocke et al. (2009) and conducted the five generic steps: *1) definition of review scope 2) conceptualization of topic 3) literature scope 4) literature analysis and synthesis 5) research agenda*. More detailed information about the literature analysis are in the respective papers of this dissertation.

1.3.5 Sensemaking, Interpretation, and Generation of Rich Insights

Sensemaking was mostly a collaborative endeavor involving interactions with other researchers and practitioners. In a series of workshops, meetings, and symposia, we deepened the insights obtained from the case study. This activity required an in-depth examination and further iterations of data analyses in which we interpreted the extensive field data by switching between the artifact perspective and social interaction perspective, along with an intensive examination of the scientific literature. We conducted a genre analysis in which we categorized the collected artifacts and viewed them through an artifact-in-use perspective to shed more light not just on the IT artifacts themselves, but more importantly on what role they play in innovation practices, and particularly on how they get mobilized by individuals and mediate interactions between them (Yates and Orlikowski, 1992). Genres serve as socially recognized types of communicative action that shape practices and, over time, organizing structures through their routinization in everyday work (Yates and Orlikowski, 2007). In a particular domain, such as digital innovation, genre analysis facilitates understanding the epistemic practices that produce outcomes, because "in identifying and labeling genres we try to capture the gestalt of the various components of the communicative act" (Kwasnik and Crowston, 2005, p. 82). In capturing these enacted genres in the context of innovation, we were able to identify a variety of materially mediated activities, which we could then subsume to more specific digital innovation practices. This not only allowed us to critically reflect on these practices, but also to compare the innovation techniques of a typical product company (BITS) with those of a typical engineering company (CustomSoft).

In addition, we provided the case companies with continuous feedback and opportunities to reflect on their own practice (Walsham 2006). Having key informants from the companies review our study reports and papers enabled them to reflect on

our findings and report any discrepancies with their interpretations. We discussed the findings of the study in multiple intensive workshops and presented them at company-internal talks to help practitioners reflect on and improve their own practices.

1.4 Contributions of this Dissertation

This section provides an overview of the main findings and scientific contributions of this dissertation, and explains the connections between the individual papers. Figure 2 illustrates the conceptual relationship between the dissertation's papers. It is categorized along the main topics as specified in section 1.2, namely the role of artifacts and social interaction in, as well as tools to support digital innovation practices. Each category distinguishes between articles that focus on 1) conceptual foundations, which create knowledge contributions in the form of theories or concepts, and 2) practical applications, which create knowledge contributions by illustrating how one can derive actionable advice for practitioners from these insights.

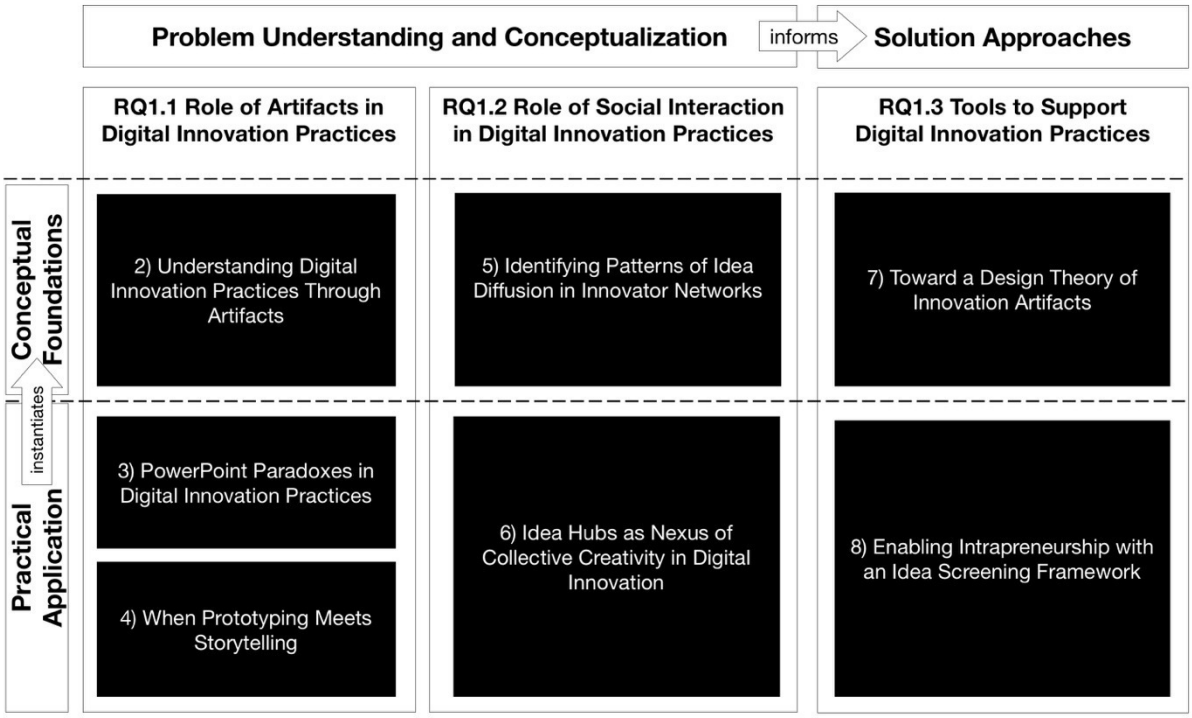

Figure 1-2 - Overview of Relationship between Research Papers in this Dissertation

As elaborated in the previous section, this dissertation's key idea is to study digital innovation practices from an artifact perspective and a social interaction perspective. Thus, it answers the research questions RQ1.1 (*what role do artifacts play in digital innovation practices?*) within three papers and RQ1.2 (*what role does social interaction play in digital innovation practices?)* within two papers. Two further papers design tools for

enabling digital innovation practices. The paper “Understanding Digital Innovation Practices Through Artifacts” (sections 1.4.1 and 2) identifies and conceptualizes four characteristic practices and clarifies the role of artifacts therein. The paper “PowerPoint Paradoxes in Digital Innovation Practices” (sections 1.4.2 and 3) provides an in-depth analysis of one specific artifact, namely PowerPoint, and its entanglement into digital innovation practices at BITS. And the paper "When Prototyping Meets Storytelling" (sections 1.4.3 and 4) examines the role of the software prototype in digital innovation practices. These three papers elaborate the artifact perspective on digital innovation, focusing on RQ1.1.

The subsequent two papers elaborate the social interaction perspective on digital innovation practices, focusing on RQ1.2. The paper “Identifying Patterns of Idea Diffusion” (sections 1.4.4 and 5) develops a research model for capturing the diffusion of innovative ideas throughout the social network of a company. Based on this conceptual understanding, the paper “Idea Hubs as Nexus of Collective Creativity in Digital Innovation” (sections 1.4.4 and 6) empirically studies the focal points of social interaction (here termed idea hubs) and identifies three influencing factors that affect individuals’ choice of idea hubs.

Such qualitative and behavioral social studies are often likely to generate theoretically relevant, novel, and interesting insights that inform further quantitative or design-oriented work. Two further papers condense the lessons learnt from directly applying that knowledge in the organizations and give actionable advice for practitioners. While the former four papers create descriptive knowledge that helps to understand a phenomenon, two further papers provide prescriptive knowledge and structured guidance. One paper presents two design principles for using artifacts to communicate ideas purposefully (section 1.4.6 and 7), and another paper presents the design of an idea screening framework that supports the evaluation, selection, and tracking of ideas in employee-driven innovation (sections 1.4.7 and 8). These two papers again provide insights from the design of artifacts that shape the use of artifacts and therefore also directly relate to RQ1.1 and RQ1.2.

In a nutshell, this dissertation

1. Conceptualizes digital innovation practices from an artifact perspective and a social interaction perspective through an in-depth qualitative-interpretive case study.
2. Provides tools to support digital innovation practices based on the insights obtained from the qualitative case study through a smaller design science research project.

In line with the widespread distinction between social science/behavioral IS research and engineering/design IS research (Briggs and Schwabe, 2011), this research can be classified into two streams: 1) a behavioral stream with case studies to explore, understand, and conceptualize social phenomena and their corollaries and 2) a design stream with development and implementation of tools to shape and support digital innovation practices. Whereas the design stream of this research project was insightful from a practitioner's perspective, and further work could deeper pursue this stream, the larger share of this dissertation focuses on the behavioral stream to develop rich insights and conceptualizations of social phenomena in the context of digital innovation. These insights can then again inform future studies on the design of innovative IS that shape digital innovation practices, which is however out of the scope of this dissertation.

1.4.1 Understanding Digital Innovation Practices Through Artifacts

The first paper in this dissertation examines RQ1.1, namely what role do artifacts play in digital innovation practices. Because of their above-mentioned mediating role (cf. section 1.2), artifacts have the potential to radically transform the way companies innovate. This implies a growing need for deeper understanding the underlying innovation practices in which artifacts are embedded. Drawing on an in-depth qualitative examination of the empirical data obtained from the software companies BITS and CustomSoft, this paper identifies and conceptualizes four digital innovation practices, namely: *making sense of an idea, aligning mental models, negotiating solution paths,* and *crafting an idea*. We interpret each practice along a pluralist object framework, recently proposed by Nicolini et al. (2012), that comprises *boundary objects, epistemic objects, activity objects,* and *material infrastructure*.

This paper's contribution is threefold:

1) The practice-based model of digital innovation specifies a set of practices and their interrelations for enabling digital innovation in organizations that shows how people innovate with and toward artifacts. As implications for innovation management we suggest a broader shift in perspective, namely from managing and controlling top-down specified innovation processes towards facilitating and enabling bottom-up emerging innovation practices.

2) The paper provides a practical example how combining multiple artifact lenses facilitates a deep-going analysis of digital innovation practices in companies. IS scholars interested in understanding the role of artifacts in different contexts may

apply this approach in other settings, such as health, telecommunications, research, government, and manufacturing.

3) The paper clarifies the role of artifacts in digital innovation practices, thereby informing future studies on the design and use of information systems that support these practices.

Placing a stronger focus on artifacts, this paper identifies and conceptualizes four practices through which people enact digital innovation. The conceptual model in figure 3 sets the four practices in relation to each other. Innovators strive for a clearer understanding of an idea by *making sense of an idea*. Thereby, they identify uncertainties (e.g. open questions or issues that need clarification) and conflicts (e.g. different and mutually exclusive possible viewpoints, competition for resources). These uncertainties and conflicts flow into *aligning mental models* and *negotiating solution paths,* respectively. In the former, stakeholders that are involved in the innovation endeavor develop a shared understanding. In the latter, the innovation teams narrow down the possible solution space and agree on necessary actions. In both practices, innovators identify and mutually exchange solution options, whereby the output of *aligning mental models* is a shared understanding of and the output of *negotiating solution paths* is a decision on these, respectively. Both outputs flow into *crafting an idea*, where innovators employ necessary measures to advance idea materialization. In a learning by doing fashion, the innovator thereby obtains refined ideas, which again flow into *making sense of an idea*, where the whole process starts anew.

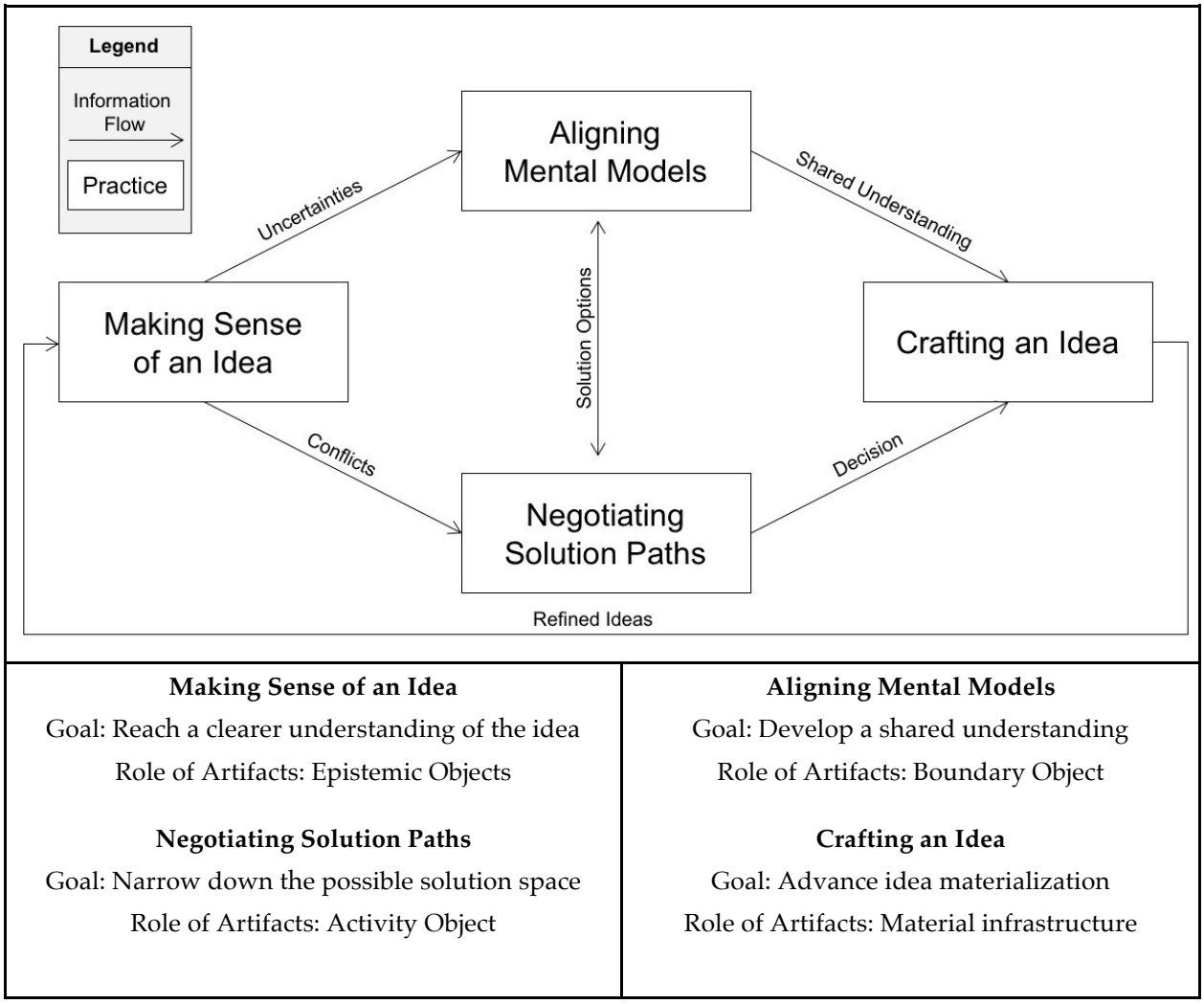

Figure 1-3 : Practice-based Model of Digital Innovation

This practice-based model extends existing knowledge in that it foregrounds the bottom-up emergence of digital innovation from an artifact-based viewpoint. It specifies a set of digital innovation practices and illustrates the requirements for which to design social and technical innovation support. IS scholars with an interest in understanding and improving digital innovation may draw on this contribution to better understand the environmental conditions under which artifacts play different roles that require different supporting measures. The goal should be to analyze and design artifacts to meet the respective requirements of the underlying practices.

In sum, this paper suggests future digital innovation research not only to appreciate the unique characteristics of digital artifacts, but also to understand digital artifacts-in-use and how people enact them in the underlying innovation practices. Innovating in the digital age requires us to better understand the process of digitalization, unfolding through the continuous production and reproduction of artifacts. While this

corresponds to previous research indicating that the digitalization of the analog has important implications for the innovation process itself (Yoo et al., 2012, 2010), our study shows that digital innovation is also a human practice mediated by both digital and physical artifacts. Any study of digital innovation practices should carefully examine the interconnected role of physical and digital artifacts in parallel.

Our comprehensive artifact analysis shows that employees choose from a variety of digital and physical artifacts, depending on whether they pursue a clearer understanding of an idea for themselves, want to create a common understanding among relevant stakeholders, need to identify, coordinate, and agree upon important steps to narrow down the problem-solution space, or advance the process of idea materialization through targeted execution of necessary actions. In this regard, this paper specifies artifact use practices and, thereby, contributes to explain how individuals appropriate both digital and physical tools.

The paper „Understanding Digital Innovation Practices Through Artifacts" is currently in preparation for submission (revise and resubmit) to the Journal of the Association for Information Systems (JAIS).

1.4.2 PowerPoint Paradoxes in Digital Innovation Practices

Whereas the previous paper conceptualizes digital innovation practices and the role of artifacts therein in general, this paper provides an in-depth analysis of PowerPoint use. Thereby, paper illustrates the important role of artifacts in digital innovation practices with a prominent example of an artifact, namely PowerPoint. PowerPoint is an indispensable component of modern business communication, implying a growing need to better understand its role in different contexts. Whereas many studies have examined effects of using PowerPoint in one specific setting, the ambivalent user experiences afforded by PowerPoint-specific characteristics are often overlooked. This paper contributes to this gap by theorizing PowerPoint's dual role in the context of digital innovation. Through a dialectical synthesis, grounded in qualitative field data from BITS and CustomSoft and related literature, we identify three 'PowerPoint Paradoxes', i.e. conflicting yet interrelated ambivalences that co-exist over time (Smith and Lewis, 2011) in different PowerPoint practices: 1) *Freedom* and *Captivity*, 2) *Clarity* and *Ambiguity*, and 3) *Scarcity* and *Abundance*. Moreover, we identify three corresponding ways of coping with these paradoxes. Thereby, this paper extends PowerPoint literature by describing phenomena that result from using PowerPoint in an underresearched context, namely digital innovation. Our contribution further

extends digital innovation literature by illustrating the ambivalent effects of using PowerPoint as an idea communication tool.

The contribution of this paper is twofold:

1) *Understanding the Role of PowerPoint in Digital Innovation Practices:* Researchers and practitioners interested in PowerPoint's role in different organizational and communicational practices (for an overview, see section 2 and Kernbach et al., 2015; Schoeneborn, 2013; Yates and Orlikowski, 2007) can learn about the surprising phenomena and tensions that arise from using PowerPoint in a novel and underresearched context, namely digital innovation. This paper provides a dialectical synthesis of the contradictory ambivalences (i.e. paradoxes) that innovators experience when using PowerPoint, and shows how innovators cope with these paradoxes. Thereby, this paper extends the ongoing PowerPoint discourse in that it theorizes PowerPoint paradoxes in digital innovation practices.

2) *Understanding the Use of IT Artifacts for Communicating Ideas in Digital Innovation:* Researchers and practitioners seeking to understand how technical characteristics of IT artifacts support knowledge-intensive work practices in digital innovation (cf. Yoo et al., 2010) get an opportunity to critically reflect on the characteristics of an arguably dominant innovation tool - namely PowerPoint - and how innovators use it. Essentially, this paper presents a set of PowerPoint practices that help to better understand how and why people use IT artifacts like PowerPoint for communicating ideas. Innovators and innovation managers can use the here presented PowerPoint practices as a guideline to understand how using PowerPoint can support their practices. Thereby, this paper sheds more light on the actual practices of innovative employees in two software companies and contributes a practice-based perspective to the discourse on the use of IT artifacts in digital innovation.

Table 3 provides an overview of the three paradoxes. The three paradoxes each constitute two contradictory yet interrelated propositions that exist simultaneously and persist over time (Smith and Lewis 2011). The first paradox juxtapposes PowerPoint's provided freedom and captivity, and emphasizes how PowerPoint gives users a high amount of perceived freedom, but also holds them captive. The second paradox dialectically examines PowerPoint's provided clarity and ambiguity, and foregrounds how PowerPoint affords clarification, but also complication. And the third paradox capitalizes on the parallel facilitation of information scarcity and information abundance in PowerPoint. Reflecting on these three paradoxes with the help of Poole and Van de Ven's (1989) suggested coping strategies and related

literature, this paper identifies a set of coping strategies that involve temporal or spatial separation, and acceptance.

Table 1-3 : Overview of PowerPoint Paradoxes

Paradox	Thesis	Antithesis	Synthesis
Freedom/ Captivity	PowerPoint's *malleability* affords expressing creative ideas freely.	The PowerPoint template, the lack of semantic representability, and social orthodoxies around PowerPoint hold people captive and inhibit creative interaction.	PowerPoint affords individual creativity in early innovation process phases and constrains interpersonal creativity later.
Clarity/ Ambiguity	PowerPoint's *modularity* and *sequentiality* afford clarification by structuring thoughts, simplifying complex issues, and breaking down large topic blocks into smaller ones.	PowerPoint affords complication through *semantically ambiguous* and *interpretatively flexible* slides.	PowerPoint affords individual clarification during the production of slides, but also affords interpersonal complication during the consumption of slides.
Scarcity/ Abundance	PowerPoint's *limited functionality* and *limited space per slide* afford information scarcity by constraining the amount of displayable information.	PowerPoint's *digitality*, *integrability*, and *sequentiality* afford information abundance through potentially unlimited (re)production, dissemination, and storage of slides.	PowerPoint affords scarcity of high-quality information on the slide level and, thereby, affords abundance of low-quality information on the document level.

Seeing PowerPoint as ready-to-hand, transparent, deeply entangled component of digital innovation practices reveals that the tool often remains subliminal, routinized and imperceptible when used. Against this backdrop, this paper shows how a careful examination of such a mundane digital artifact as PowerPoint can reveal complex, multifaceted, and interesting insights for information systems researchers and practitioners. While using PowerPoint brings certain benefits, it equally comes at a cost. Through its paradoxical affordances and constraints, PowerPoint contributes to the ongoing democratization and digitalization of innovation processes by giving people at all hierarchy levels a voice through their creation and dissemination of PowerPoint slides (cf. Kaplan, 2011). But the extensive use of PowerPoint in

organizations also generates a number of problems, such as inhibited creativity, misinterpretations, and poorly manageable knowledge. Since digital innovation practices are still a largely unexplored terrain, this paper provides a practical example of how an in-depth artifact analysis (here: PowerPoint) can deepen our understanding of the underlying practices, and the relationship between the two. After all, it is not the technology that makes a difference, but how it is used.

The working paper "PowerPoint Paradoxes in Digital Innovation Practices" is currently in preparation for journal submission. It builds on a previous publication, named "PowerPoint Use and Misuse in Digital Innovation", which has been published in the proceedings of the 23rd European Conference on Information Systems (ECIS 2015).

1.4.3 When Prototyping Meets Storytelling: Practices and Malpractices in Innovating Software Firms

Whereas the previous paper analyzes the role of PowerPoint in digital innovation practices, another important artifact that plays an influential role in digital innovation practices is the software prototype. Prototyping is a complex, multifaceted activity whose outcome depends on a variety of factors. In software engineering, prototyping and storytelling are widely regarded as distinct but related approaches to support requirements elicitation and validation (Budde and Zullighoven, 1990; Hickey and Dean, 1998; Kordon and others, 2002; Overmyer, 1991; Parnas and Clements, 1986), idea experimentation and exploration (Bäumer et al., 1996; Carleton and Cockayne, 2009; Doll, 2009; Kelley, 2001; Lichter et al., 1993), facilitating communication (Budde and Zullighoven, 1990; Lichter et al., 1993), and decision making (Lichter et al., 1993; Schneider, 1996; Urban, 1992). Thus, this paper focuses on the question how people communicate innovative ideas with software prototypes in organizations.

Prototyping can support and enrich the communication about innovative ideas and, if done properly, be a low-risk and cost-efficient approach to develop innovative software systems. However, a prototype alone does not elicit and validate requirements, explore and experiment with ideas, facilitate communication, or make decisions by itself. Just as a picture can be worth a thousand words if we know what it shows, a prototype can be worth volumes of documents if, and only if, we know the story it is supposed to tell (Schneider, 1996). The prototype itself does not indicate what it does as it provides no explanations or judgements (Schneider, 1996). This knowledge cannot be fully explicated in the prototype alone, but rather resides implicitly in the minds of its developers, viewers, and users. When any of these stakeholders leaves the team or forgets lessons learned after the prototype is no longer

used, part of the acquired knowledge that could have been useful in other contexts will be lost (Schneider, 1996). So far, research has mostly treated the construction, communication, and preservation of implicit knowledge as black box, overlooking the practices through which people enact these in social interactions with prototypes. In turn, storytelling has only ever been seen as a means to create a common understanding about as-is and to-be between storyteller and listener, in essence reducing stories to a bridge between developer and user in the sense of use cases and usage scenarios (Wende et al., 2014). Thus, existing literature can only provide few answers in terms of theoretical concepts, empirical insights, or let alone practical guidelines (Doll, 2009; Schlachtbauer et al., 2013).

This paper offers a distinct perspective in which storytellers are innovators who need to convince decision makers by combining the expressiveness of an illustrative prototype with the persuasiveness of an appealing story. Here, decision makers are understood as managers and sponsors in their formal role, but also as users, business experts, technical experts, and other peers who are consulted during the decision-making process with the goal to not only understand each other mutually, but also to persuade others. Thus, a good storyteller should ensure that the story has an interesting, appealing, and authentic script, highlights only the relevant aspect with respect to the intended audiences, and provides listeners with opportunities to shape the idea while also staying clear and consistent as it spreads. Table 4 provides an overview of the identified practices and malpractices.

Table 1-4 : Overview of Practices and Malpractices

Category	Practice	Malpractice
Choosing the Script	Holding an "I Have a Dream" Speech	Telling Fairy Tales
Determining the Level of Detail	Presenting an "Elevator Pitch"	Using a Sledgehammer to Crack a Nut
Engaging with the Audience	Crafting the Story Together	1) Take It or Leave It 2) Premature Closure
Spreading the Message	Coupling Prototype and Narrative	Running from Pillar to Post

Prototypes can make story more compelling and help to make a persuasive case for a desirable future (i.e. holding *I Have a Dream* speeches), but it is crucially important that the script is as close to an existing or envisioned real world situation of the listener as possible (i.e. avoiding *Fairy Tales)*. Storytellers should use prototypes to focus the story's level of detail on highlighting only the aspects relevant to the listeners while

leaving out irrelevant ones (i.e. telling *Elevator Pitches*) instead of gold-plating and over-engineering technical aspects of the prototypes that are not conducive to illustrate the core features (i.e. *Using a Sledgehammer to Crack a Nut*). *Crafting the Story Together* by using prototypes to attract listeners and to obtain feedback continuously is an effective way to engage with the audience, as opposed to pushing the listener to use something that has been developed in a quiet chamber (i.e. forcing them to *Take It or Leave It*), or jumping to conclusions about what the listeners really want too early (i.e. *Premature Closure*). And *Coupling Prototype and Narrative* can be an effective means to spread the message convincingly and consistently among stakeholders, while sparing storytellers the efforts of *Running from Pillar to Post* and trying to please everybody.

This contribution informs software engineering scholars and practitioners about the importance of prototyping and storytelling in organizations. It identifies a set of practices that help to better understand the role of prototyping and storytelling for communicating ideas, persuading decision makers, and transferring implicit knowledge. An important practical implication is that storytelling and prototyping are deeply intertwined and should thus be integrated together into software engineering methods like agile software development. When combined and integrated into agile software development, prototyping and storytelling can increase customer involvement and satisfaction through early, continuous, and frequent delivery of working software (i.e. prototypes and the stories inextricably bound to them), facilitate close, co-located, and periodical cooperation between business people and developers (effectively by means of stories), and improve product simplicity.

The Paper "When Prototyping Meets Storytelling: Practices and Malpractices in Innovating Software Firms" has been accepted for publication at the 39th International Conference on Software Engineering (ICSE2017), Track "Software Engineering in Practice".

1.4.4 Identifying Patterns of Idea Diffusion in Innovator Networks

While the so far presented papers conceptualize digital innovation practices from an artifact perspective, the following two papers focus on the social interaction perspective on digital innovation practices (RQ1.2). The first paper elaborates a research model for capturing the diffusion of ideas throughout a social network. The diffusion of innovative ideas throughout a social network of a company depends crucially on how people are connected and influence each other. However, existing conceptualizations of innovation diffusion and peer influence do not suffice to capture the multi-faceted nature of idea diffusion, leaving a gap in our current understanding

of how ideas are constructed and negotiated in social interaction. This paper conceptualizes the diffusion of emergent innovative ideas throughout the communication channels of a social network of companies. It suggests to examine the impact of peer influence on the percolation of idea-related artifacts. It elaborates a network-based perspective to study idea diffusion, and provide a preliminary analysis through a qualitative examination of interviews and artifacts collected at BITS. The paper argues that the diffusion of innovative ideas throughout a social network of innovators depends crucially on how people are connected and influence each other, and particularly on the advocacy of influential individuals. It further argues that peer influence and social contagion are important factors that influence the diffusion of innovative ideas throughout a social network. By juxtaposing various approaches to study knowledge diffusion, we argue that such models provide a useful starting point for the analysis of idea diffusion in social networks. For instance, one identified pattern through which ideas diffuse is the centralized hierarchical diffusion pattern, in which a group of gatekeepers selects and allocates resources to ideas.

This paper reports on research-in-progress. We could not yet get access to the data that would have been necessary to complete the analysis, yet still this paper elaborates the conceptual foundations that are practically applied in the following paper. Future work could focus on a conceptualization of different kinds of peer influence and their respective impact on idea diffusion. Studies could draw on our contribution to examine additional factors such as the role of the organizational configuration or the type of the idea under observation.

The research-in-progress paper "Identifying Patterns of Idea Diffusion in Innovator Networks." has been published in the proceedings of the 34th International Conference on Information Systems (ICIS 2013).

1.4.5 Idea Hubs as Nexus of Collective Creativity in Digital Innovation

Building on the ideas of the previous paper, this paper conceptualizes the focal points of social interaction in digital innovation as *idea hubs* to understand social interaction in digital innovation practices. The analysis focuses on instances of idea hubs at BITS and CustomSoft, where we conducted an in-depth case study over a two-year period. The paper zooms in on the focal points of social interaction at the case companies through a qualitative examination of semi-structured interviews we conducted with experienced innovators, digital trace data we collected from online networking platforms, and a longitudinal series of participant observations.

The contribution of this paper is threefold.

1) this paper contributes to the emerging literature on digital innovation by analyzing and conceptualizing two software companies' focal points of social interaction as idea hubs. The analysis is focused on concrete instances of idea hubs as nexus of collective creativity. In doing so, this paper identifies a set of idea hubs and corresponding social interaction practices. These can be classified into *offline idea hubs*, where employees collectively create ideas in co-located formal and informal meetings, and *online idea hubs*, where geographically distributed employees collectively create ideas using collaboration software in a synchronous or asynchronous way. This study provides not only insights into employees' online interaction practices (e.g. with social media), but also into the offline interaction practices, as well as the intersection between the two. These different kinds of idea hubs are an important factor in supporting the social interaction practices of innovative employees.

2) The paper dialectically examines the appropriateness of idea hubs in different contexts regarding the innovation practices in which the idea hubs are embedded. This dialectical appraisal has practical implications in that it illustrates the selection decisions made by different stakeholders who engage in collective creativity. It also has theoretical implications in that it provides a state of the art analysis of social interaction in digital innovation at two software companies. Namely, employees often use co-located informal idea hubs for establishing and maintaining social connections, for freely generating ideas, and for getting first feedback in a trusted environment. They frequently choose these casual gatherings to get a feeling of whether further persuading an idea could be worthwhile or not, as for instance reflected in the observed practice of discussing ideas in coffee corners. However, while such idea hubs tend to be suitable settings for getting feedback, they tend to be less suitable for making concrete decisions on further steps. When employees think the idea is ready for invoking more impact, they often turn to more formal gatherings such as board meetings, fairs, or conferences, where they can place ideas more prominently and possibly obtain needed resources, but also risk getting negative feedback that can ultimately stop the idea.

3) The paper identifies three influencing factors on which the choice of idea hubs depends, namely a) the material infrastructure that surrounds the idea hub, b) the innovation process phase in which employees use the idea hub, and c) personal characteristics of the individuals that are connected through the idea hub. That is, employees choose idea hubs depending on 1) how infrastructural arrangements allow collective creativity to unfold, 2) the necessary formality of interaction, which tends to increase with advancements in the innovation process phase, and 3) the possibility to

involve influential promotors (Fichter 2009) or catalysts (Tortoriello et al. 2014). These three influencing factors help to explain why in a corporate environment, despite a variety of digital artifacts innovators can choose from, offline interaction still plays a major role in facilitating digital innovation. In times where Enterprise Social Media (ESM) play an increasingly important role and gain growing research attention, one should still bear in mind the major role of offline interaction and human aspects. Digital technologies should therefore be in line with the emergent character of digital innovation practices to fully unfold their potential.

Further research could draw on our contribution to examine how leading innovative companies engage in collective creativity to identify best practices and structured guidance for innovation.

The paper "Idea Hubs as Nexus of Collective Creativity in Digital Innovation" has been published in the proceedings of the 36th International Conference on Information Systems (ICIS 2015).

1.4.6 Communicating Ideas Purposefully: Toward a Design Theory of Innovation Artifacts

The previous papers focus on how digital innovation practices can be understood and conceptualized by analyzing artifact use and social interaction. The following two papers complement our previously deepened understanding about digital innovation practices by creating knowledge about the design of tools that support these practices.

Whereas it is widely acknowledged that the innovative capacity of a company depends crucially on how well it supports employees in realizing ideas, there is a lack of understanding how employees can communicate ideas purposefully. In this paper, we argue that the innovative capacity of a company depends crucially on how employees communicate ideas through artifacts. At first, an idea exists only as an abstract conception, an image in the mind of a person (Partridge 1991, pp. 303f). That image is likely to evolve as the person sees the physical image that answers to the idea of it. However, explicit guidance on how to design and use such artifacts is scarce. Without thorough examination of interdependencies between objects, idea communication, and innovation processes, this objective seems hardly feasible. Our study bridges this gap by elaborating a prescriptive, artifact-based perspective on innovation practices. This paper introduces the term "innovation artifact" and define it is as an underspecified representation of an envisaged solution that is used to communicate an emerging idea across intersecting social worlds in a corporate environment. Innovation artifacts facilitate creating a tangible preview of a possible

future product or service. As a first step towards a design theory (Gregor and Jones 2007), we interviewed 32 experienced innovators and collected 216 instances of innovation artifacts at BITS, such as whiteboard sketches, software diagrams, usage descriptions, PowerPoint slides, prototypes, and business cases. Drawing on an in-depth examination of this data using the inductive design theorizing framework, recently proposed by Gregor et al. (2013), we identify two design principles how individuals can use innovation artifacts to persuade and collaborate. In doing so, we do not only clarify what role innovation artifacts play in communicating ideas in a corporate environment, but also give structured guidance on how innovation artifacts can be designed to communicate ideas purposefully. Principle 1 states that innovation artifacts help persuading relevant stakeholders through proof-of-value (here termed "doing the right things") and proof-of-concept (here termed "doing the things right"). Principle 2 states that innovation artifacts help fueling collaboration by acting as boundary object (i.e. create an object of shared understanding) and activity object (i.e. embody a certain degree of incompleteness to motivate interaction). From an employee's perspective, these guidelines constitute a valuable instrument on how to exploit the potential of tangible representations for realizing an idea. From a manager's perspective, the design principles may facilitate better structuring of innovation processes by demanding concrete artifact deliverables. By drawing on our contribution, future research can place a stronger focus on various kinds of innovation artifacts to better understand the complex interactions in innovation.

The paper "Communicating Ideas Purposefully: Toward a Design Theory of Innovation Artifacts" has been published in the proceedings of the 22nd European Conference on Information Systems (ECIS 2014), and presented at the ancillary theory development workshop of the European Journal of Information Systems (EJIS).

1.4.7 Enabling Intrapreneurship with an Idea Screening Framework

As a practical instantiation of the above-conceptualized innovation artifact, this paper reports on a sub-study where we designed and implemented an innovation artifact at BITS. The closely involved research relationship with BITS was helpful for designing solution concepts that are deeply grounded in the innovation culture of the company. The design, development, organizational implementation, and evaluation of these solution concepts were the focus of this sub-study. One of these solution concepts resulted in a working prototype called *innovation cockpit*.

The innovation cockpit is an idea screening framework that facilitates the evaluation, selection, and tracking of ideas in employee-driven innovation. It provides

an aggregated view over existing innovation ideas to identify and anticipate trends, allows finding synergies between ideas, and ultimately makes the innovation activity within a company measurable and manageable. It provides a micro and macro level view over existing innovation ideas. Moreover, by clustering the different parameters of each dimension, it is possible to identify classes of innovation and spot common risks and opportunities.

This paper reports on the design and implementation of an idea screening framework at BITS and demonstrates how it can support the evaluation, selection, and tracking of ideas, which are crucial for employee-driven innovation. Our key lesson learnt from this design process is that an information system that supports idea screening needs to be a servant of two masters. On one hand, it needs to provide decision support by illustrating the relevant information for deciders in the right level of abstraction. In that regard, the idea screening framework needs to be a precise model of an idea that provides unambiguous decision-relevant information. But at the same time, the idea screening framework needs to provide a sufficient level of ambiguity to allow for interpretive flexibility and serve as boundary object across intersecting social worlds (Star and Griesemer, 1989). We contribute to extant literature by illustrating the dual role of idea screening and putting it into the work context of employee-driven innovation at a software company. We further show how other companies can instantiate our idea screening framework and customize the designed dimensions and attributes to their specific needs.

The working paper "Enabling Intrapreneurship with an Idea Screening Framework" is under review at the International Journal of Entrepreneurship and Small Business (IJESB), where it has been invited to a special issue. It builds on an earlier publication, namely "Designing an Idea Screening Framework for Employee-driven Innovation", which has been published in the proceedings of the 49th Hawaii International Conference on System Sciences (HICSS 2016).

1.5 Conclusion

This section provides answers to the research questions, condenses the contributions of this dissertation, and summarizes its key theoretical and practical takeaways. As we have seen in section 3.1, Walsham (1995a) argued that there are certain kinds of generalizations from interpretive case studies, namely 1) development of concepts, 2) generation of theory, 3) drawing of specific implications, and 4) contribution of rich insight. This dissertation provides all four types of contributions, to varying extents. The papers of this dissertation provide rich insights into the digital

innovation practices at two software companies. We seized the unique opportunity to conduct an intensive case study through which we could examine their digital innovation practices in depth, and conceptualize the artifact and social interaction practices in the actual work context. To the best of my knowledge, no previous study provides such a rich empirical account of digital innovation practices in a corporate environment. We have leveraged these rich insights to develop novel theoretical concepts, such as digital innovation practices, innovation artifact and idea hub). This provided us with an opportunity to better understand digital innovation practices in a corporate environment and draw specific implications about the relationship between practices, artifacts, and social interaction in digital innovation.

Namely, we have worked toward a nascent theory about the design and use of information systems that support digital innovation practices, and further developed, expanded, or revised existing theories on digital innovation, practices, artifacts, and social interaction. For instance, we have explicitly addressed the research questions RQ1.1 (*What role do artifacts play in digital innovation practices?*) by providing a practice-based model of digital innovation through one comprehensive, general artifact analysis (sections 1.4.1 and 2) and two additional in-depth, specific artifact analyses of PowerPoint use (sections 1.4.2 and 3) and Prototyping (sections 1.4.3 and 4). Furthermore, we have addressed RQ1.2 (*What role does social interaction play in digital innovation practices?*) by studying patterns of idea diffusion throughout the social network of a company (sections 1.4.4 and 5), as well as studying the focal points of social interaction and the influencing factors of individuals' choice thereof (sections 1.4.5 and 6). Moreover, we have addressed RQ1.3 (*How can organizations enable digital innovation practices?)* by showing how this descriptive knowledge can be extended to create prescriptive guidance about the design of artifacts that support digital innovation practices (sections 1.4.6 and 7), and we have documented the lessons learnt from designing such an artifact ourselves (sections 1.4.7 and 8).

This dissertation provides thought-provoking impulses for digital innovation researchers and practitioners. It argues that a stronger emphasis on the actual practices of innovative people improves existing conceptualizations of digital innovation in software companies. Part of the contribution of this dissertation is to elicit the requirements of managing innovation in the digital age through creating a better understanding and an improved conceptualization of digital innovation practices. For instance, we illustrate the requirements for using artifacts to support innovation practices (sections 2, 7), we show how prototypes or PowerPoint can be used for creative work and persuasion (sections 3 and 4), we provide starting points for

supporting informal networking and collective creativity (sections 5 and 6), and we identify important criteria for idea screening (section 8). From these insights, it is possible to develop tools that enable digital innovation practices in a corporate environment. Our studies add to the body of knowledge on digital innovation in that they identify and conceptualize important practices that foreground the bottom-up emergence of ideas from an employee-driven, artifact-based, and interaction-centric perspective (section 2). In doing so, we provide starting points for designing organizational and technical support, for instance by providing design principles for innovation artifacts (section 7) or an idea screening framework for enabling intrapreneurship (section 8). IS scholars with an interest in understanding and improving digital innovation may build on our contribution to better understand the environmental conditions under which the artifacts they design or analyze play different roles. The case companies BITS and CustomSoft already benefit from this reflection and improvement of their own practices. It is therefore likely that a broader class of companies can also benefit from these contributions.

This dissertation fills an important gap in the research agenda that seeks to better understand digital innovation in an organizational context (Yoo et al., 2012). The key idea is that a parallel emphasis on artifacts and social interaction helps to deeper understand the information requirements of different stakeholders in digital innovation practices. When establishing this dual approach, the two perspectives can draw on synergies to their mutual benefit: On the one hand, we identified and conceptualized a key set of practices through our comprehensive artifact analysis (sections 2-4). These conceptualizations of practices contribute to a deep understanding of the settings in which ideas are constructed and negotiated. Building on these insights, we could conduct a more focused analysis of the social interaction aspects within these practices, specifically the patterns of idea diffusion (section 5) as well as the focal points of social interaction and individuals' choice thereof (section 6). In turn, studying the role of social interaction helped to understand how social coalitions evolve, how people are connected, and how they influence each other, even before collaboration over artifacts emerges in the first place. Hence, part of this dissertation’s contribution is to illustrate the interplay between artifacts and social interaction. By combining both perspectives, this dissertation extends the existing theoretical knowledge of digital innovation practices. It generates rich insights into digital innovation practices in software companies; It illustrates the role of artifact usage in digital innovation practices and the effect of specific artifact characteristics on

these practices; It studies the role of social interaction in digital innovation practices; And it points to synergies between the artifact and social interaction perspectives.

This dissertation follows the call for novel approaches to managing digital innovation projects in a corporate environment that embrace the unique characteristics of digital artifacts and the nearly limitless possibilities they provide (Yoo et al. 2010). Digital innovation implies the need to structure the development of innovative digital products through the targeted application of artifacts in appropriate practices. Organizations need to create facilitating and enabling conditions in which all employees can participate in the innovation process (Desouza, 2011). One important implication of our artifact studies is that one single type of artifact does not suffice to facilitate digital innovation (cf. section 2). Rather more, a focus on multifaceted constellations of practices, artifacts, and social interaction is necessary to allow digital innovations to emerge. By enacting innovation practices with readily available artifacts at hand, the practices themselves inherit the distinctive and unique characteristics of digital artifacts, such as programmability, traceability, and malleability (Yoo et al. 2010). Our studies indicate that managing digital innovation projects in a corporate environment means a departure from traditional IT/IS project management approaches, which mostly rely on project management methods that are not specific to IT (Yoo, 2013). We contribute to this recent and ongoing discourse in IS literature by helping to explain digital innovation through untangling the complex entanglements of practices, artifacts, and social interaction. We suggest future research to also think of a broader shift in perspective from managing and controlling towards facilitating and enabling innovation (section 2).

In line with ongoing discourses on the sociomateriality of IS, we argue that practices can be seen as outcome of the relationship between human agency and material characteristics of technology in use (Leonardi, 2011; Orlikowski and Scott, 2008). Functional affordances of technological objects are essential material properties that facilitate the performance of some action in a specific use context (Markus and Silver, 2008). This helps to explain the observed complex interrelations between employees' interactions and characteristics of material infrastructure that surrounds them, and thereby helps to specify how digital innovation changes traditional ways of innovating (Fichman et al., 2014; Yoo et al., 2010). For instance, we were able to provide a revised critical appraisal of PowerPoint that complements many existing studies that characterize the technology as either beneficial or detrimental. At the same time, the illustrated manifold use practices of PowerPoint contribute to a better understanding of digital innovation itself. Our study suggests that PowerPoint should not be seen as

a static part of an organization, but rather as part of innovation practices that is enacted within a larger whole. In turn, digital innovation should also be seen as a bundle of dynamic practices where PowerPoint mediates interaction to a large extent (section 3). Moreover, we could find out that innovators use software prototypes not merely for creating a common understanding, but also for storytelling and persuading decision makers (section 4). Our study on software prototypes suggest that prototyping and storytelling should be integrated together into digital innovation practices.

Our social interaction studies identify and conceptualize a set of idea hubs and dialectically examine their appropriateness in different contexts. They distinguish three influencing factors of idea hub choice that emerged as important from our social interaction analysis, namely 1) the role of the infrastructure and its material characteristics in which the idea hub is situated, 2) the role of the innovation process phase in which the idea hub is selected, and 3) personal characteristics of the participants that are connected through the idea hub. This adds to the body of knowledge on digital innovation in that it identifies specific practices that foreground the bottom-up emergence of ideas that are collectively created in various settings (sections 5 and 6).

These studies also indicate that innovation often does not become a purely digital practice in companies. For instance, although the business model of both case companies is based on digital products and services, offline interaction with physical artifacts still plays an important role (sections 2 and 6). Our analysis of idea hubs as nexus of collective creativity shows how employees choose from a variety of online and offline idea hubs, depending on infrastructural, individual, and process-related aspects (section 6). This helps to explain why employees often appropriate tools such as enterprise social media in ways that are quite different from the intended ones. In times where Enterprise Social Media play an increasingly important role and gain growing research attention, one should still bear in mind the major role of offline interaction and human aspects. Digital artifacts are important to support those practices that are primarily physical, and interpersonal relationships play a crucial role in social interaction. For instance, our study found that the involvement of influential individuals plays an important role in both companies' digital innovation practices. This points to the strong connection between an idea and the person who carries it. Digital artifacts afford novel forms of innovation practices and social (section 6), but this does not imply that digital technologies will eventually transform every important aspect of modern social life. At the two case companies, offline interactions still played a major role, particularly when important decisions were necessary. The use of digital

artifacts should therefore be in line with the emergent character of innovation practices to fully unfold their potential.

From these explanatory insights, we derived two design principles that suggest how the purposeful use of innovation artifacts can help to persuade and collaborate (section 7). Moreover, as a practical application of these principles we designed an Idea Screening Framework and demonstrate how it can support the evaluation, selection, and tracking of ideas (section 8). Our key design lesson learnt is that an information system that supports idea screening needs to be a servant of two masters, namely innovators and deciders. Thereby, we provide an example of how an information system can support digital innovation practices.

In a nutshell, this dissertation suggests extensions to the existing literature on digital innovation. It helps explain the bottom-up emergent nature of digital innovation in a corporate environment, enacted in the individual practices of employees; it provides a revised critical appraisal of the role of artifacts and social interaction in digital innovation practices; it illustrates a systematic account of how innovators enact practices with artifacts, in private or open settings; it facilitates a deeper going analysis of how the active and passive roles of artifacts and social interaction can be unpacked; and puts a greater focus on organizational and technological designs that favor individual and collective innovative minds.

1.6 Outlook

One of the many lessons I learned during this project is that research is as much about answering questions as it is about raising new ones. Hence, this research should be seen in the light of its limitations that raise some interesting questions for future work.

Broaden the Scope: As I have argued in section 5, the contribution of this dissertation can be classified according to Walsham's (1995a) four types of generalizations that may result from interpretive case studies. However, it should be noted that these generalizations should not be seen as objective truths, but rather as tendencies that provide "explanations of particular phenomena derived from empirical interpretive research in specific IS settings, which may be valuable in the future in other organizations and contexts" (Walsham, 1995, p. 79). In interpretive research, the concept of generalizability (i.e. the extent to which the findings generalize to other populations) is therefore often replaced by the concept of transferability (i.e. the ability of the findings to transfer to situations with similar parameters, populations and characteristics) (Lincoln and Guba, 1986). Since the goal of this dissertation is to

understand and conceptualize digital innovation practices from an artifact perspective and a social interaction perspective, we chose qualitative methods and inductive theory building to identify and describe the phenomenon. Our studies focus on either one or two case companies and a limited set of technologies to create rich insights into these practices. For instance, our in-depth analysis of PowerPoint use at BITS shows that material characteristics of artifacts have important implications for digital innovation practices. Future studies may observe if the illustrated use of PowerPoint is specific to software firms or applicable in other types of organizations (e.g., consulting firms or universities and research institutions). It could also be interesting to examine the affordances of other artifacts (such as prototypes or social media) in a digital innovation context in more detail. Moreover, our comprehensive artifact analysis shows how a plurality of artifacts mediate digital innovation practices at BITS and CustomSoft. Hence, part of our contribution is to condense these rich insights in a way that makes them transferable to a broader class of companies who share common basic assumptions with our two case companies. These include software companies that encourage employees to innovate and engage in interdisciplinary IS development, as well as industrial manufacturers, telecommunications corporations, consulting firms or financial service providers, which today have large software development branches, too. Further empirical work may examine whether the here observed findings hold in these other contexts as well. Moreover, further quantitative studies could develop metrics and test the suggested interrelations and their relative effects, for instance in laboratory experiments or with surveys. This may help increase external validity of the findings, which is, however, not in the scope of an interpretive researcher, who sees truth rather as a social construction than as something objectively given (Klein and Myers 1999).

Identify "Best" Practices: We conceptualized the digital innovation practices at two software companies, both culturally innovative but not necessarily innovation leaders. The uniqueness of our sample has provided us with the opportunity to identify an employee-driven, artifact-based, and interaction-centric perspective on digital innovation practices. We seized the opportunity to provide rich insights into the actual interactions between human actors and material artifacts. From that, we conceptualized digital innovation practices from an artifact perspective (sections 1.4.1-1.4.3) and a social interaction perspective (sections 1.4.4-1.4.5), and created a set of design principles (section 1.4.6) as well as an idea screening framework (section 1.4.7) to suggest ways to support digital innovation. Whereas these insights offer possibilities to deeper understand digital innovation practices, they alone do not offer

comprehensive prescriptions on how to support these practices *ideally*. Instead, part of this dissertation's contribution is to identify existing innovation practices and subject them to a critical dialectical examination of their appropriateness for digital innovation. Future behavioral field studies may examine how leading innovative companies engage in digital innovation practices to identify best practices and structured guidance for innovation. Moreover, future design-oriented studies may develop and evaluate artifacts that support the here specified digital innovation practices.

Study the Cultural Dimension: All research involved carrying out extensive fieldwork in a close relationship with software companies that are headquartered in Switzerland. Whereas I gathered large parts of the data at nearshore subsidiaries in Europe and offshore subsidiaries in Asia, most interaction took place either in Switzerland, or in European subsidiaries with employees sharing a similar western mindset. Hence, it cannot be excluded that there is a cultural dimension influencing the findings. Our studies found no significant cultural differences regarding digital innovation practices, but that could also result from a strong "export" of the companies' culture (e.g. governance structures, managers etc.) to the foreign subsidiaries. Future behavioral field studies may explicitly focus on examining the cultural dimension of digital innovation practices, especially in projects that require cross-cultural collaboration.

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2 Understanding Digital Innovation Practices Through Artifacts

(JOURNAL ARTICLE)

Raffaele Fabio Ciriello, Alexander Richter, and Gerhard Schwabe
University of Zurich, Binzmühlestrasse 14, 8050 Zürich, Switzerland
ciriello@ifi.uzh.ch
aricher@ifi.uzh.ch
schwabe@ifi.uzh.ch

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Abstract: Digital innovation disrupts the way companies innovate, implying a growing need to deeper understand the underlying practices that are mediated by a plurality of material objects. Grounded in an in-depth case study at two Swiss software companies and an extensive set of collected empirical data, this paper contributes a practice-based model of digital innovation that consists of *making sense of an idea, aligning mental models, negotiating solution paths,* and *crafting an idea*. Our interpretation of each practice is structured along a 'pluralist object framework' by Nicolini et al. (2012). This study contributes to literature on digital innovation by 1) specifying a set of practices for enabling digital innovation in organizations, 2) illustrating how to analyze digital innovation practices, and 3) clarifying the role of artifacts in digital innovation practices.

Keywords: digital innovation, practice theory, boundary object, epistemic object, activity object, material infrastructure, IS development, interpretive case study

2.1 Introduction

Innovating has become a fundamental and necessary practice to thrive and survive as a company in today's globalized and competitive markets (Tidd and Bessant, 2011). Since many years, companies seek to innovate by opening up towards networks of internal and external collaborators (Chesbrough, 2003), helping employees to realize ideas within the boundaries of their organization (Desouza, 2011), or seizing the nearly limitless opportunities to innovate facilitated by digital artifacts (Yoo et al., 2012). Whereas the importance of continuous innovation rises, there is an important gap in our understanding of digital innovation. So far, digital innovation research has mainly focused on new emerging forms of innovation in the digital age and their respective impact on the market, leaving unanswered the question of how people may actually bring about and enact these changes. As a result, we know yet little about enabling digital innovation in organizations. Responding to this practical demand, the need to study innovation with a focus on the characteristics of digital artifacts has recently been brought forward, as calls and special issues in leading IS journals also reflect (Fichman et al., 2014; Nambisan et al., 2014; Yoo, 2013; Yoo et al., 2012, 2010).

This paper endorses a practice perspective to understand how organizations create enabling conditions for digital innovation. From a practice theorist's point of view, the use of artifacts constitutes a fundamental starting point to understand human practices (Carlile et al., 2013). In most existing practice studies, however, innovativeness and creativity play an only peripheral role. Leveraging a pluralist object framework, recently developed by Nicolini et al. (2012) for analyzing collaboration practices, we suggest a novel, practice-based model of digital innovation. Empirically grounded in an in-depth case study we conducted at two Swiss software companies, the model provides a deep understanding of digital innovation practices, and the role of therein-embedded artifacts. Over a period of more than two years, we were able to study and participate in the development of innovative software products as embedded researchers. Through this relationship, we obtained rich insights of the underlying practices and realized the need to address digital innovation from a practice perspective. We observed that people enact digital innovation through alternating sequences of individual practices and group practices, and realized that existing literature is far from being comprehensive enough to examine fundamental questions regarding the important role of artifacts in digital innovation practices. The present study therefore fills an important gap in the digital innovation literature by answering the guiding research questions:

1) *Through which practices do people enact digital innovation in organizations?*

2) *What role do artifacts play in digital innovation practices?*

Definitions: Digital Innovation Practices and Artifacts

With *digital innovation practices*, we mean the practice of using combinations of artifacts both as objects (i.e. means, resource, equipment) to create an innovation, and as objective (i.e. end, outcome, product) of the innovation endeavor. In turn, the term *artifact*, when used in this paper, refers to any kind of material object that innovators create and/or use in practice. An artifact, in our understanding, is always practice-oriented. It can be a means or an end, but the underlying practice determines its purpose (Kaptelinin and Nardi, 2009). In digital innovation practices, artifacts can manifest an abstract idea conceptualization and are thus often emergent, unfinished, and partial. They may represent an envisaged solution, embody multiple viewpoints, and enable a shared understanding (Star and Griesemer, 1989). An artifact can mediate both individual work and collaboration (Nicolini et al., 2012). It can be used in a private space, confronting the innovator with a first prospect of a new idea, thereby advancing the chain-of-thoughts and inspiring further development (Rheinberger, 1997). In addition, an artifact can be used to collect feedback and build a social coalition for a further development of the innovation. As such, the artifact can be an important tool to transgress the many gates that are associated with innovation processes.

Our contribution to digital innovation literature is threefold:

1) The practice-based model of digital innovation specifies a set of practices for enabling digital innovation in organizations that shows how people may innovate with and toward artifacts. As implications for innovation management we suggest a broader shift in perspective, namely from managing and controlling top-down specified innovation processes towards facilitating and enabling bottom-up emerging innovation practices.

2) We illustrate how combining multiple artifact lenses facilitates a deep-going analysis of digital innovation practices in companies. IS scholars may apply this approach in other settings, such as health, telecommunications, research, government, and manufacturing.

3) We clarify the role of artifacts in digital innovation practices, thereby informing future studies on the design and use of information systems that support these practices.

The remainder of this paper is structured as follows. Section 2 embraces the theoretical foundations by summarizing related literature on managing digital innovation, endorsing a practice perspective, and introducing the pluralist object framework that guided our analysis of artifacts in digital innovation practices. Section 3 provides information about our interpretive field study (Walsham, 2006, 1995) at two Swiss software companies, and our use of qualitative methods for data analysis and theory building. Section 4 analyzes the set of digital innovation practices that emerged

from our study, namely *making sense of an idea, aligning mental models, negotiating solution paths* and *crafting an idea*. Section 5 presents the practice-based model of digital innovation and continues with a discussion of its implications for research and practice. Finally, section 6 sums up the key takeaways of the study and raises promising questions for future research.

2.2 Related Work

2.2.1 Digital Innovation

Yoo et al. (2010, p. 725) define *digital innovation* as "the carrying out of new combinations of digital and physical components to produce novel products". This already implies a need to see digital innovation as a practice, a "carrying out", with distinctive characteristics that differentiate digital from traditional innovation.

Digitalization of previously analog information is a precondition for digital innovation. Through digitalization, products inherit capabilities from the digital artifacts they embody, such as increased programmability, malleability, traceability, accessibility, shareability, tailorability, and modularity (Yoo et al., 2010). These digitally enriched products provide an environment of open and flexible affordances that bring forth new forms of innovations and innovating, such as combinatorial and distributed innovation (Yoo et al., 2012). Here, *combinatorial innovation* refers to new products and services with embedded digital capabilities that emerge through recombination of digital and physical artifacts, such as e-readers, smartphones, or smart cars (Yoo et al., 2012). *Distributed innovation* refers to novel forms of organizing, such as virtual team work, that emerge from the lower cost of communication and coordination, through which the innovation practices disperse geographically and move towards the periphery of organizations (Yoo et al., 2012). While it still remains to be clarified how these practices actually look like in order to support them effectively, we can safely assume that digital innovation requires a radical departure from how we as IS researchers traditionally see IS development and innovation processes (Fichman et al., 2014). Research indicates that we are only at the beginning of imagining the potential of digital artifacts (Yoo et al., 2012) and that it is time to elaborate a body of literature on digital innovation that embraces and refines established innovation management concepts (Yoo, 2013).

Previous innovation management research indicates that shrinking innovation cycles and new digital artifacts make innovation practices ever more networked and employee-driven (Chesbrough, 2003; Desouza, 2011). For instance, the concept of open

innovation suggests that companies should purposefully use both inflows and outflows of knowledge to accelerate internal innovation and expand the market for external innovation (Chesbrough, 2003). This leads to a decentralization, where companies replace traditional Research and Development (R&D) departments with more distributed work structures (Desouza 2011). Because R&D departments would enable only selected experienced employees to work on ideas with a long-term impact, ever more organizations collect ideas from all sides (Neyer et al., 2009), with companies such as Apple or Google providing prominent examples of an entirely new self-understanding of the employee. Many companies therefore try to encourage employees to act entrepreneurial within the boundaries of their organization, providing technical, financial, and professional resources (Desouza, 2011).

The prevailing view in the existing innovation management literature is a discrete, linear, and sequential innovation process with clearly ordered, differentiated, and consecutive phases. For instance, Tidd and Bessant (2011) divide the innovation process into *search*, *select*, *implement*, and *capture*. Chesbrough (2003) differentiates between *research* and *development*. Desouza's (2011) innovation process consists of *idea generation*, *advocacy & screening*, *experimentation*, *commercialization*, and *diffusion & implementation*. And Fichman et al. (2014) distinguish between *discovery*, *development*, *diffusion*, and *impact*. This perspective is based on the assumption that the innovation process usually takes a linear path. Repetitions of single phases are a rarely necessary exception. A dogmatic implementation of the linear process perspective would prohibit to skip phases. It would also be impossible to move backwards into the process or to carry out several phases at once. One phase could only start when the previous one is fully completed. However, it throws into question whether this is actually the case in practice. Can innovations really be specified clearly, completely, and precisely in advance? Can innovations really be developed exactly as specified without unanticipated technical or social constraints? And will the end user always refrain from using the innovation in unexpected ways, or from not using it at all? The reality looks quite different (Wessel, 2014). The major disadvantage of the strictly sequential approach is that the practical benefit of the innovation can be evaluated at a very late stage only. When companies fail to notice change requests or tacit requirements in time, necessary adjustments can only be accomplished with considerable effort. As a result, a lot of innovation potential may remain unused and the success rate of innovations in the market may remain relatively low. The strict separation of single innovation process phases may therefore be an inadequate idealization. In sum, we argue that the linear process perspective on innovation is

widely applied, but has serious disadvantages that strongly limit the practical use and usability of such process models. In this paper, we show how a practice perspective can help to overcome some of these weaknesses.

2.2.2 A Practice Perspective on Digital Innovation

The so far summarized literature suggests that digital artifacts require us to radically rethink received views about innovation. Whereas an innovation management perspective is helpful for looking at general innovation processes on an organizational level, a practice perspective is more appropriate for looking at the bottom-up emerging, multifaceted, and serendipitous nature of digital innovation.

A practice perspective facilitates focusing on the work and behavioral intentions of innovating people, and foregrounds their actual practices (Majchrzak et al., 2012). While there is currently no such thing as a unified practice theory, the many existing practice-based approaches share some commonalities that offer a distinctive perspective on social phenomena (Nicolini, 2012): 1) They picture a world that is constantly in the making and in which doing instead of being lies in the center of attention. 2) They suggest that the basic unit of analysis shall be practices instead of practitioners, i.e. innovating and entrepreneuring instead of innovators and entrepreneurs. 3) They foreground the importance of, and relationship between, people and objects in social affairs.

A practice perspective helps us to see innovation not only as a one-off moment without a history or future, but rather as a continuous, ongoing, and collective accomplishment of something people do and enact (Pantzar and Shove, 2010). For instance, doctors do not only practice medicine, but are doctors *because* they practice medicine, and one can only become a doctor in an already existing practice of medicine (Riemer and Johnston, 2014). Accordingly, as a 'digital innovator', a person is a carrier of the practice of digital innovating and any innovation process, whether digital or not, can only unfold as a sequence of practices. The appropriate level of analysis to capture the complexity of digital innovation is, therefore, at the level of human practice (cf. Tuomi, 2002, p. 19).

2.2.3 An Artifact Lens on Digital Innovation Practices

A practice perspective can provide a fundamental understanding of digital innovation. But how can we conceive practices, and build theories that embrace how people enact them? Practice theorists argue that this is possible by looking at practices through an artifact lens (Nicolini et al., 2012). When defining practices as “embodied, materially mediated arrays of human activity centrally organized around shared

practical understandings", Schatzki (2001, p. 2) directs special attention to the mediating role of material artifacts in a practice. In line with this view, practice-based studies in the IS field have gone hand in hand with a parallel emphasis on the social and material nature of practices, where the relationship between human activity and technology is one of mutual mediation (Leonardi, 2011; Orlikowski and Barley, 2001). As Orlikowski (2007) puts it, a practice perspective unveils that "materiality is integral to organizing, positing that the social and the material are *constitutively entangled* in everyday life" (p. 1437, italics in original).

Artifacts affect many aspects of our work and private life, and practices can be seen as outcome of the relationship between human and material aspects of technology use (Cecez-Kecmanovic et al., 2014). As a consequence, many academics direct considerable research attention to the role of artifacts in practices, and how they can support knowledge sharing, collaboration, and innovation (Carlile et al., 2013). In this context, an artifact lens facilitates uncovering the "process of materialization enfolding in material-discursive practices of IS development, implementation, and use" (Cecez-Kecmanovic et al., 2014, p. 812). For instance, a carpenter who is hammering encounters a hammer as something for doing what carpenters do, namely hammering nails, and for being what carpenters are, namely craftsmen; the hammer draws its role from the carpentry practice, and draws its purpose from the practice it is used for and constitutive of, namely hammering (Riemer and Johnston, 2014). Accordingly, as digital technology exists only as technology-in-use embedded in a specific practice, the researcher may obtain a better understanding of the underlying practices through studying artifacts in use. Not unlike archaeologists, who study ancient cultures through analyzing left material traces, practice theorists seek to understand contemporary sociality through the ecology of artifacts that surrounds and shapes our everyday life (Knorr-Cetina, 1997).

The existing practice literature knows various artifact lenses that make apparent the important role of artifacts in the context of various practices. Nicolini, Mengis, and Swan (2012) recently compiled some of the most important ones into one perspective. This pluralist object framework embraces four lenses that we discuss in the following: *boundary objects*, *epistemic objects*, *activity objects*, and *material infrastructure* (see table 1).

Table 2-1 : Lenses in Nicolini et al.'s (2012) Pluralist Object Framework

Lens	Short Description
Boundary Object (Star and Griesemer, 1989)	Boundary objects function as translational and transformational devices at social boundaries. They enable collaboration by developing and maintaining coherence across social worlds.
Epistemic Object (Rheinberger, 1997)	Epistemic objects embody what one does not yet know and thereby generate desire and attachment through their unfulfilled nature.
Activity Object (Engeström, 1987)	Activity objects embody different types of knowledge, thereby generating contradictions, triggering collaboration, directing activities, and sparking innovation.
Material Infrastructure (Star and Ruhleder, 1996)	Material infrastructure comprises everyday mundane objects that support and shape collaboration in their conjunction by forming an ecology of supporting objects.

The four lenses share the common basic assumption that human practice and material artifacts are mutually constitutive; that artifacts and objects participate in the accomplishment of practice and make the practice durable over time; and that artifacts connect practices across space and time (cf. Nicolini, 2012). At the same time, each lens highlights different aspects of artifacts with regard to provided affordances, kinds of boundaries bridged, degree of completeness, historical conditions, and sources of conflict and novelty. The framework can help shed new light on the shifting role of artifacts, for instance motivating collaboration, allowing participants to work across different types of boundaries, or constituting the fundamental infrastructure of an underlying practice (Nicolini et al., 2012).

2.2.3.1 Boundary Object

The *boundary object* lens sees artifacts as translational and transformational devices at functional, professional, or organizational boundaries (Carlile, 2002). Artifacts become boundary objects when they are flexible yet robust enough to develop and maintain coherence across intersecting social worlds, satisfying the information requirements of each (Star and Griesemer, 1989). They are flexible because their structure has to be sufficiently loose to allow for interpretive flexibility among collaborating social groups (Bartel and Garud, 2003). But they are also robust because they provide a form of reification around which practices, cooperative work, and emergent, shared meanings can be coordinated (Lave and Wenger, 1998). A considerable amount of research has examined practices through the boundary object lens. Boundary objects range from visible artifacts such as PowerPoint slides, project repositories (Nicolini et al., 2012), standardized forms, sketches, drawings (Carlile,

2002), and software prototypes (Doolin and McLeod, 2012), over more abstract objects such as metaphors (Koskinen, 2005), up to discussions and research projects (Kimble et al., 2010). In fact, the boundary object concept has been used so extensively and stretched so far from its original formulation that authors begin to question the persistence of its utility – if everything is a boundary object, the concept loses expressiveness (Star, 2010).

The boundary object lens may help to shed more light on *how* artifacts play an active role in various practices (Levina and Vaast, 2005). Taken alone, however, boundary objects do not help us understand *why* people make the effort for alignment, and we know yet little about their potential for creativity and innovativeness (Eppler et al., 2011). Nicolini et al. (2012) argue that a fixation on boundary objects is in fact unnecessary, given that there are complementary concepts, as we summarize in the following.

2.2.3.2 Epistemic Object

The *epistemic object* lens foregrounds not only the how, but also the why of objects in practices. Originally introduced by science historian Hans-Jörg Rheinberger (1997), the epistemic object lens describes a kind of artifact that is "always in the process of being materially defined" (Knorr-Cetina, 2001, p. 181). Epistemic objects are question-generating and act as a source of interest and motivation for further research and development "by virtue of their preliminarity, of what we do not yet know about them" (Rheinberger, 2005, p. 407). Their lack of completeness creates emotional attachment and the desire to fill a void (Knorr-Cetina, 1999). As object of desire, epistemic objects keep together individuals in groups, making them feel and work like a community because of "what they [are] after and not simply because of who they are" (Nicolini et al., 2012, p. 620). For this reason, epistemic objects can be regarded as a central source of organizational innovation and change (Miettinen and Virkkunen, 2005). Being absorbed into the practice of pursuing an epistemic object is a key reason why curious people are willing to work long hours. Classic examples are the objects of investigation in strategizing efforts, scientific research projects, or innovation processes. An important characteristic of epistemic objects is their capacity to unfold indefinitely, meaning that they can never be fully attained (Knorr-Cetina, 1997). Thus, partial objects mediate their investigation, in a sense that the investigators interact with the necessarily partial material representations of the epistemic object, such as models, maps, blueprints, or sketches (Werle and Seidl, 2015).

2.2.3.3 Activity Object

With the *activity object* lens, Nicolini et al. (2012) offer a complementary concept that foregrounds the emergent, fragmented, and constantly expanding nature of artifacts in practice. Rooted in the cultural-historical activity theory of psychologists Lev Vygotsky and Alexei Leontiev, the activity object lens sees artifacts as "prospective outcomes that motivate and direct activities, around which activities are coordinated, and in which activities are crystallized (...) when the activities are complete" (Kaptelinin and Nardi, 2009, p. 6). This view foregrounds that all practices are essentially object-oriented and artifact-mediated. They are *object-oriented* in a sense that each practice both pursues and produces some kind of object (or objective), i.e. durable concerns and carriers of motives that generate foci of attention, effort, and meaning (Engeström, 1987). And they are *artifact-mediated* in a sense that interactions between the person and its object are mediated by cultural artifacts that are internalized by participating in common practices with other people (Miettinen and Virkkunen, 2005). Classic examples are software prototypes, shared to-do lists, or the different concerns of researchers in interdisciplinary research projects. The activity object lens offers the distinctive insight that artifacts can function "not only as instruments of translation (as per boundary objects) and sources of attraction (as per epistemic objects), but also as triggers of contradictions and negotiation" (Nicolini et al., 2012, p. 620). Activity objects are problem spaces into which people project different views and perceptions to negotiate a consensus. They are necessarily partial and not entirely visible to any one of the participants (Nicolini et al., 2012). The shared creation of activity objects, used as means of reflection and transformation, is a key to changing practices (Miettinen and Virkkunen, 2005). And, because they are inherently contradictory, multifaceted, and embody multiple interests and interpretations, activity objects can be a source of negotiation, learning, and innovation, "as shared tools and concepts are built to depict and handle the contradictory object and the conflicting motives related to it." (Engeström, 1987, p. xxxii).

Of all theoretical lenses used in the pluralist object framework, activity theory is by far the richest in tradition. Given that there are in fact quite different views on the nature and role of objects among one generation of activity theorists to the next, we shall point out that Nicolini et al. (2012)'s formulation of activity objects stems from a rather Leontievian line of thinking. Miller (2011) discusses how contemporary uses of concepts such as *artifact-mediated activity* differ substantially from Vygotsky's original interpretation of artifacts and mediation. At the heart of Vygotsky's work in the 1920s,

which formed the basis for the cultural-historical school, lies a clear distinction between technological tools and psychological tools. Vygotsky insisted that the two shall not be conflated because of their radically different mediating role in the development of higher mental functions such as thinking and speaking, which he viewed as *psychological activity*. Leontiev both adopted and extended Vygotsky's work when he originally developed his activity theory in the 1930s. His formulation of mediation centers on the idea of *practical activity*, in the Hegelian sense of "Praxis". Accordingly, later uses of the term *object* appear to be quite different from one branch of activity theory to another (see (Blunden, 2010) for an overview): Those who adopt Vygotsky's distinction between psychological and technological tools tend to view the object as part of the mental concept a person forms of some task or problem. The mental concept is the form of psychological activity by means of which the object is realized. For those who adopt Leontiev's idea of artifact-mediated practical activity (including Nicolini), the object is situated in the objective world at which the activity is aimed at bringing about. Objects are generators and foci of attention, motivation, effort and meaning. They are a moving target that is not reducible to conscious short-term goals. We thank one of the anonymous reviewers for raising this point.

2.2.3.4 Material Infrastructure

While the above introduced three lenses foreground the important role artifacts sometimes play in practices, Nicolini et al. (2012) add, for the sake of completeness, that artifacts not always live in the center of our attention. More often than not, they perform subtle background work and remain unconsciously transparent in everyday work. The *material infrastructure* lens foregrounds the work of these mundane objects, or the "'stuff' of everyday live" (Nicolini et al., 2012, p. 622). Material infrastructure can be seen as any web of objects that emerges “when local practices are afforded by a larger-scale technology, which can be used in a natural, ready-to-hand fashion” (Star and Ruhleder, 1996, p. 112). Classic examples are software work tools that are embedded in a larger web of object including other software, hardware (PC, mouse, keyboard, monitor, etc.), desk, chair, building, electricity, and so on. Taken alone, these artifacts may seem transparent or even insignificant, but without them constituting the fundamental material infrastructure of everyday work, practices would be difficult to enact.

2.2.3.5 Summary and Gap

The pluralist object framework and related literature indicate that an artifact lens facilitates a deep-going analysis of the bottom-up emerging practices in which the

artifacts are embedded. We should bear in mind that artifacts are not necessarily bound to one of these four theoretical approaches, and neither do they follow a one-way trajectory. They are rather able to change their roles back and forth, depending on the social and material constellation in which they are embedded (Nicolini et al., 2012). While an artifact's material characteristics do matter, the way in which the artifact is used in practice is certainly more important for the definition of its role and function (Levina and Vaast, 2005).

In a nutshell, we identify the following research gaps from the literature:

1) Recent advances in digital innovation research indicate that digital technologies pose new challenges and opportunities for the management and development of innovations in companies (Yoo et al., 2012, 2010). The prevailing linear process perspective is insufficient for capturing the complexity of artifact-mediated digital innovation practices. If we want to enable digital innovation in organizations, we need a deeper understanding about the nature of the underlying practices in a digital innovation context. Our first research question is therefore: *Through which practices do people enact digital innovation in organizations?*

2) Recent advances in practice theory indicate that an artifact lens provides an opportunity to analyze the nature of practices in various contexts (Nicolini et al., 2012). However, existing practice-based studies disregard the potential of artifacts in an innovation context. If we want to understand the nature of digital innovation practices, we need a deeper understanding about the role of artifacts therein. Thus, our second research question is: *What role do artifacts play in digital innovation practices?*

2.3 Method

We conducted an interpretive case study (Klein and Myers, 1999; Walsham, 2006, 1995) at two Swiss software companies in order to obtain an in-depth understanding of digital innovation practices from a participant's perspective. Over the course of two years, our approach was to zoom in and out iteratively on the practices at the companies (Nicolini, 2009). We entered the research site with little previous understanding of digital innovation practices, and the theoretical foundation evolved over time according to our deepening understanding (Walsham, 2006). We began with an in-depth case study in one location and then expanded to another location by following emerging relations (Walsham, 2006).

2.3.1 Research Relationship

The above summarized related literature indicates that digital innovation practices can be observed in organizations with high activity of employee-driven innovation (Desouza 2011), high degree of internal and external collaboration (Chesbrough 2003), and high involvement of digital artifacts in the development and outcome of the innovation (Yoo et al. 2010). Hence, we turned to the following two companies that focus on creating conditions where employees realize ideas. In both companies, work is focused on creating novel, IT-based solutions to novel problems, for which they heavily rely on an extensive network of customers, partners, and research institutions.

Case Company 1: Banking and IT Solutions (BITS)

Through the development, distribution, and operation of its proprietary core banking system, BITS rapidly grew to a market leader for banking software. The global financial crisis after 2008 increased the pressure to innovate and diversify the company's market offerings. In 2012, the executive board initiated a research collaboration with our university institution on improving the innovative capacity of the around 1400 employees worldwide. At that time, independently thereof, the first author of this study was employed at BITS, where he actively participated in the development of a new software product, and obtained an important practical understanding of the underlying work practices. The author joined our emerging research collaboration with a PhD project while staying involved at BITS as embedded researcher to cooperate with employees and maintain constant access to data, infrastructure, and people.

Case Company 2: Custom Software Engineering (CustomSoft)

As an engineering company founded by a group of PhD students, the core business of CustomSoft is the development of software applications on client order. Customer segments include transport, health, and space agencies, as well as public administration, banks, and insurances. In addition to software development, the around 350 employees offer complementary services, such as technical consulting, project management, and requirements engineering. In an effort to better leverage their employee's creative potential, the management board initiated a research collaboration with us. This comparative study with CustomSoft helped us to validate, extend, and refine the findings of the BITS study.

The style of involvement with BITS was that of an embedded researcher having in-depth access to data, infrastructure, and people, who viewed the researcher as one of 'them' (Walsham 2006). The style of involvement with CustomSoft was that of an outside observer who was not seen as having a direct personal stake in various interpretations at outcomes, with personnel being relatively frank in expressing their views (Walsham 2006). Through these complementary approaches, we had the unique opportunity to study practices in five different innovation projects. Table 2 provides an overview of the studied innovation projects.

Table 2-2 : Studied Innovation Projects

Project	Short Description	Selection Criteria
BITS Innovation Projects		
Mobile Banking Suite	Multi-channel solution for smartphones, tablets, and web browsers for a variety of market segments such as private and retail banking, wealth advisory, and asset management.	This project required a radical rethink of the company as a whole. Traditionally a provider of core banking software, BITS recognized the need to "go mobile".
Web Self-Service	Online marketplace that enables customers to download and install software packages for BITS products.	This project was to a high extent driven by the ideas of employees.
Standard Banking Suite	Standard software as a service offering relevant business processes, including customizations for various banking segments and country specific regulations.	This project required high collaboration across nearly all departments, and also embraced various external collaborators.
CustomSoft Innovation Projects		
In-Train Cockpit View	Tablet/ smartphone app that enables train passengers to stream the locomotive driver's view on attractive train routes in real-time, along with route information.	This project was initiated and driven by employees.
Holiday Apartment Sharing	Online Platform where landlords can create an online rental presence for their holiday apartment.	This project was initiated and driven by employees.

2.3.2 Data Collection

As typical for interpretive research, we used an iterative approach to data collection and analysis, moving back and forth between theories and the different interpretations of the case study material until a coherent picture emerged (Klein and Myers, 1999). Our data collection followed the principle of triangulation (Silverman, 2006, p. 291). We examined the research issue from different sides, compiling multiple interpretations obtained from interviews, observations, field notes, and documentary material into a rich dataset (Klein and Myers, 1999). Based on the principle of theoretical sampling, we selected, collected, and analyzed new data slices according to what was necessary for the emerging theory (Glaser, 1978). Table 3 summarizes the main steps and their respective outputs in the data collection process, and the following paragraph provides more details.

Table 2-3 : Data Collection

Data Source	Data Collection Events	Total Amount
Interviews	Participants: First Wave 2013 (32) - BITS Mobile Banking Suite (8) - BITS Web Self Service (12) - BITS Standard Banking Suite (7) - BITS Cross-Functional (5) Participants: Second Wave 2014 (30) - BITS Web Self Service (1) - BITS Standard Banking Suite (26) - BITS Cross-Functional (3) Participants: Third Wave 2014 (33) - CustomSoft In-Train Cockpit View (10) - CustomSoft Holiday Apartment Sharing (10) - CustomSoft Cross-Functional (13)	95 Interviews 95 Participants Word Count: 612,401 Length - total=5677 minutes - average=59.76 minutes - minimum=19 minutes - maximum=104minutes
Artifacts / Archival Data	Artifact Type (#BITS / #CustomSoft) - Handwritten Sketch (19 / 11) - User Interface Mockup (64 / 13) - Usage Description (13 / 1) - Issue Ticket (23 / 1) - PowerPoint Deck (116 / 6) - Software Diagram (44 / 7) - Text Document (120 / 17) - Business Case (3 /0) - Software Prototype (13 / 4) - Video Presentation (3 / 2)	480 artifacts - BITS: 418 artifacts - CustomSoft: 62 artifacts
Participant Observation	Passive - workplace observations, formal project meetings, workshops, presentations, and informal contacts Active: - giving internal talks, organizing workshops and steering meetings, collaborating with project teams	1538.5 hours

The first author was the primary responsible for collecting all data and interviewed 95 experts involved in the five innovation projects. By interviewing such a wide range of participants with differing roles and positions, we were able to document multiple interpretations of the practices under study (Klein and Myers, 1999, p. 77). We used a semi-structured interview guideline to ensure topical focus and consistency while also allowing participants to freely express their own views (Walsham, 2006). We asked participants to precisely describe concrete situations

where they used artifacts to create or communicate innovative ideas, along with an assessment of the situation. This included describing the purpose of the artifact; how well the artifact served its intended purpose; form factors along with design rationales; and user groups. During these interviews, the participants typically described concrete practices around concrete artifacts, of which we collected in total 480 from participants or intranet platforms. In addition, the author spent in total 1538.5 hours at the companies to conduct participant observations at the workplace, at formal gatherings (e.g. meetings, workshops, presentations, and fairs), and at informal gatherings (e.g. lunches, impromptu meetings). Field reports and, where possible, photographs complemented the observations.

2.3.3 Data Analysis and Interpretation

As always in interpretive research, our data analysis and interpretation followed the principle of the hermeneutic circle, which suggests that "we come to understand a complex whole from preconceptions about the meanings of its parts and their interrelationships" (Klein and Myers, 1999, p. 71). Using grounded theory methods, we inductively generated shared meaning from the collected data through qualitative data analyses and interactions between authors and informants from practice (Walsham, 1995). In multiple iterations, we moved back and forth between data and theories, interrogating field material to check whether the data supported emerging claims and, conversely, switching between theoretical lenses to make sense of the empirics (Walsham 2006).

Table 2-4 : Data Analysis

Steps	Tasks	Output
1: Coding	- Open Coding: Coding the entire data material to identify tentative categories and their possible properties and relationships.	- Over 200 mutually exclusive tentative categories (e.g. materiality, personal characteristics, process phase, purposes).
	- Axial Coding: Making connections between the sub-categories to reduce the number of codes and construct a more comprehensive scheme	- Key terms in the conceptual model such as artifact-mediated sensemaking, alignment, negotiation, and crafting.
	- Selective Coding: Unifying categories and relating them to a core category	- Core category *digital innovation practices*
2: Artifact Analysis	- Categorize collected artifacts - Reconstruct the artifact-in-use practices - Subsumption to general concepts	10 tentative artifact use practices (e.g. PowerPoint presentation, whiteboard discussion, prototype workshop).
3: Theoretical Integration	- Contextualizing the research setting - Writing up the results - Positioning the findings within literature	Practice-based model of digital innovation

Table 4 provides an overview of the main data analysis steps. We recorded and transcribed all but two interviews to capture a full description and facilitate later in-depth analysis of the participant's interpretations (Walsham, 1995). We then cross-checked the transcriptions among the research team and analyzed them in MAXQDA using open, axial, and selective coding techniques (Corbin and Strauss, 1990). We started with open coding, i.e. coding the entire data set to generate many tentative categories and their possible properties and relationships (Corbin and Strauss, 1990). In this case, we identified over 200 tentative categories (e.g. materiality, personal characteristics, process phase, practices, purposes). We proceeded with axial coding, i.e. making connections between sub-categories to construct a more comprehensive scheme (Corbin and Strauss, 1990). Here, we identified key terms that constitute the conceptual model (e.g. sensemaking, alignment, negotiation, crafting). We concluded with selective coding, i.e. unifying categories and relating them to a core category (Corbin and Strauss, 1990). In our case, based on constant comparison between our emergent conceptual model and existing theory, we identified the key research gap on digital innovation practices.

Once we realized the importance of artifacts and the multiplicity of their roles in digital innovation practices, we categorized the collected artifacts by viewing them through the artifact lenses in the pluralist object framework. The pluralist object framework provided commensurable descriptions of what we had observed and fit our puropse of analyzing practices through an artifact lens. This helped to shed more light not only on the artifacts themselves, but more importantly on what role they play in practice, and particularly on how they get mobilized by individuals and mediate interactions between them (Yates and Orlikowski, 1992). In capturing these enacted practices in the context of digital innovation, we were able to identify a variety of materially mediated activities (Schatzki, 2001). In this case, based on multiple iterative cycles of data analysis and interpretation via the pluralist object framework, we identified 10 artifact use practices (e.g. PowerPoint presentation, whiteboard discussion, prototype workshop), which we then refined and integrated into the final conceptual model.

In addition, we continuously updated the case companies with our new insights to help them reflect on their own practice and report any discrepancies (Walsham 2006). Cross-comparison of the BITS and CustomSoft findings and literature helped us to contextualize the insights. When we realized that we were entering a stage of theoretical saturation, as new data slices did not add substantially to our deepening understanding, we proceeded to a stage of theoretical integration and wrote up the

results (Glaser, 1978). In writing up the paper, we oriented ourselves towards guidelines for ethnographic texts suggested by Golden-Biddle and Locke (1993), namely authenticity, plausibility, and criticality.

2.4 Results: Digital Innovation Practices and Artifacts

This section conceptualizes the set of digital innovation practices that emerged from our case study, namely: 1) *making sense of an idea*, 2) *aligning mental models*, 3) *negotiating solution paths*, and 4) *crafting an idea*. Each practice begins with a stylized case vignette that brings along the reader into the world we observed, followed by an empirically grounded description of the practice and people's typical use of artifacts therein. The case vignettes are strongly oriented towards real occurrences, but are simplified to highlight only their salient aspects (Barter and Renold, 1999). We conclude each practice with an interpretation through the pluralist object framework provided by Nicolini et al. (2012; cf. section 2.3), serving us to assign meaning to the practices observed.

2.4.1 Practice 1: Making Sense of an Idea

Case Vignette 1: Conceptualizing the Standard Banking Suite

Emma is a Business Analyst at BITS. Since several years, she advises multiple banks on the digitalization of their front and back office work processes. From this experience, she learns that many banks share similar concerns, but BITS' engineers still have to build different solutions for every bank's slightly different requirements, causing substantial personnel cost for engineering and maintenance. 'There must be a better way to do this', Emma thinks. She opens up PowerPoint and starts drawing a conceptual map to visualize what common work processes could be supported by a configurable standard software, and how it could be tailored to bank specific work processes. Emma realizes that this could work and shows the slide to her colleague Peter, an Interaction Designer. Peter sees the potential of Emma's idea and starts sketching a user interface on paper to think about how a prototype could look like. When looking at Peter's paper prototype, Emma realizes that another class of work processes could be subsumed in one component. She is now fired with enthusiasm as the idea gradually takes shape.

A typical challenge early in any innovation endeavor is developing an understanding of the idea and its potential impacts. Here, artifacts help innovators anticipate how the idea will potentially impact the future, thereby advancing the chain-of-thought and inspiring further development. When a creative spark generates the need to create and reflect upon a tangible prospect of an idea, people turn to easy-to-use, ready-to-hand drawing tools such as mind mapping tools, PowerPoint, or just simple notepads.

For instance, many participants create early sketches in PowerPoint due to its flexibility for unrestricted free-form drawing, as exemplified here:

"Every now and then, I open PowerPoint and simply draw for myself. I illustrate my creative process in there, and when I get the impression that something interesting comes out, I present it directly and discuss it further. That can for example be an architectural model or a process model when I want to improve a process, it can also be a mockup when it's about usability." [i16, Product Manager, BITS]

This participant describes the importance of thinking an idea through for oneself before communicating it to others, and of being able to easily communicate the idea to others without many intermediate steps. In this case, PowerPoint was appropriate to sketch and communicate the idea with a tool that is widespread and universally understood. We also observed that people use free-form tools such as whiteboards, smartboards, flipcharts or notepads extensively when making sense of an idea, as exemplified here:

"I usually take a notepad and draw for myself [to anticipate] how the UI could look like. Thereby I obtain a first impression of the usability, because […] I have to think about how it will look in the end while I'm already drawing. Thereby I get to ideas, sketches, and concepts, through which I see directly when something does not make sense. Then I can throw the paper into the bin and start over. When I do it already like this, I obtain a relatively good image of how it will later look like in reality. Because (if) I first program and then have to rebuild it, then I have relatively much effort, […] while with the paper prototype I realize within 15 minutes if something does not work." [i11, Technical Lead, BITS, cf. Figure 1]

This participant describes how sketching ideas with paper and pencil helps with reflecting on the positive and negative aspects of an idea and its particularities. Contrary to a computer screen with all its sources of distraction, paper and pencil may help to stay focused on the important aspects of an idea, and force the creator to think an idea through before implementing it, thereby preventing unnecessary later correction effort.

Figure 2-1 : A software engineer scribbling together a paper prototype

Other participants prefer digital drawing tools over physical ones to support their sensemaking. For instance, an interaction designer at CustomSoft, who created visual concepts for the in-train cockpit view innovation project, uses Axure to draw user interfaces, and reflects on the experience with using this digital artifact as follows:

> *"The question is: what do you use these things for? And for me, the actual issue is: You as a designer realize what you want. You also do it when nobody else around you wants to see it. Firstly, you have to generate and discard ideas. That's the digital scrapbook; where Leonardo [Da Vinci] used to scribble his wings into, you do it electronically now - to find ways, to discard ways, to see how it feels."* [i82, Interaction Designer, CustomSoft]

In sum, *making sense of an idea* has the goal to develop a clear understanding of an idea. Here, people use artifacts to reflect upon a tangible prospect of the idea, extracting cues from the artifact to generate and refine the underlying idea. Artifacts help to anticipate what possible design paths could be relevant and what envisaged design options could be acceptable or unacceptable. As innovators consider, construct, or interact with the artifact, it helps them to organize thoughts and to understand what they really want to achieve. It can also be an important precursor for communicating an idea to others and, thereby, supports further practices.

Interpretation: Epistemic Objects in Digital Innovation Practices

Our inquiry of artifact use in digital innovation begins at the point where a creative spark leaps across the minds of innovators, and they set nascent ideas in motion. From studying BITS and CustomSoft, we learned that innovators often make sense of ideas with lightweight instruments that help them generate and refine ideas. Making sense of an idea is a fundamental practice for understanding and designing interactions between the envisaged product and its potential users. It is an ongoing practical accomplishment and feedback process in which people continuously adjust and readjust their accounts of the idea as they simultaneously shape and react to artifacts in their environment. Be it a PowerPoint drawing or a paper prototype, innovators make sense of ideas as they construct, regard, and reason around artifacts to organize their thoughts. Extracting cues from the artifact helps to separate important aspects from less important ones, linking ideas to broader networks of meaning, and developing a clearer picture of how the idea may materialize.

Interpreting these observations through the pluralist object framework, we can describe *making sense of an idea* as the practice of using artifacts to pursue an *epistemic object*. Low-maturity artifacts such as design sketches give the creator an impression of the potentials and constraints that emerge when the idea meets the realm of reality. As people create tangible prospects of their idea, they fuel an ongoing feedback process of materially defining an epistemic object that embodies what does not yet exist in the world. Epistemic objects, often partially represented as paper prototypes or sketchy screens, awake and maintain the desire to fulfill an idea. Working towards something that does not exist yet is often a crucial source of motivation. What drives people to realize ideas and invest a substantial amount of time and effort is not only the promise of a generous compensation or long-desired promotion, but also the desire for fulfillment triggered by the epistemic nature of the object. The epistemic object, for instance the possibility of an innovative product, triggers desire and attachment any time an individual comes closer to capturing it (cf. Nicolini et al. 2012). Such epistemic objects often do not motivate only one single individual, but also groups of innovators. Hence, epistemic objects may also trigger collaboration and keep together collections of creatives who alone could not make sense of the idea. But this only becomes possible when artifacts instantiate parts of the epistemic object and, thereby, facilitate and mediate its pursuit. Consider the example when the product manager used PowerPoint slides to make sense of an idea and pursue an epistemic object. Later, these slides functioned as translational device at the knowledge boundary between the product manager and relevant stakeholders.

Viewing the practice of making sense of an idea through the epistemic object lens foregrounds why artifacts spark and sustain initial motivation. In the following section, we show how the partial artifacts of an epistemic object become boundary objects that coordinate work and organize collaborative discovery at a later point in time, when the idea matures and requires alignment between social worlds.

2.4.2 Practice 2: Aligning Mental Models

Case Vignette 2: Demonstrating the In-Train Cockpit View with a Prototype

Tom is a Sales Manager at CustomSoft and has a passion for trains. One day, he fulfils a long-desired dream and takes a scenic train ride through the Swiss Alps. While the mountain landscape passes his window, Tom gets an idea. Wouldn't it be nice to view the ride from the train driver's perspective and get real-time information about the marvelous natural landmarks on the way? By chance, Tom has good contact with the train company's CIO from previous projects. As Sales Managers usually do, Tom asks the CIO if she would be interested in an idea that substantially improves their customers' experience and is excited when she responds with an invitation. Tom knows from experience that such ideas are best presented with living examples. There is no way Tom is going to bore these executives with a PowerPoint presentation! He asks his colleague Maria, a software engineer, to create a clickable prototype for a tablet as a demonstrator. When the train company's executives see the prototype they are excited: "This is exactly what I thought of earlier", says the CIO and even gives some additional ideas as input. It looks like Tom just won a new sales case. Now CustomSoft just has to build and deliver a real product...

From studying BITS and CustomSoft, we observed that the highly collaborative and network-based nature of digital innovation requires groups of innovators to speak the same language. The practice of *aligning mental models* has the goal to bring stakeholders with different views into alignment and converge on a shared understanding. Innovators, sponsors, advocates, collaborators, and gatekeepers need to be aware and in line of the envisaged idea and its potential benefits. When aligning mental models, innovators use artifacts to coordinate work, adjust interests, exchange ideas, collect feedback, establish a common language, bridge communication, and anchor discussions.

Whiteboard discussions are a typical setting at BITS and CustomSoft in which innovators meet to brainstorm, develop new ideas, explore new topics, breakdown large topic blocks, and exchange specialized knowledge. One participant regards this as *"the simplest and most efficient way to build consensus and develop a shared understanding"* [i6, Technical Lead, BITS]. Especially in technical workshops, we observed that the whiteboard is an important tool to align mental models, as exemplified here:

> [The Standard Banking Suite (SBS) project team set the agenda for the meeting as increasing service orientation in the core product in order to elaborate the basis for

the standard banking suite, which is currently the company's focus innovation project. The mission of the Web Self-Service (WSS) team is to support the implementation process and ensure compliance with the architectural patterns and technological consistency. Since weeks, however, the SBS project manager is dissatisfied with WSS' solution proposal. In his view, the proposal is too vague and does not fully reflect SBS' needs. The beamer displays a wiki page with the proposed software design from the WSS team]

SBS Project Manager: *"I simply need to know how much effort it will take to build this. How many components do we have to touch, and is the concept feasible at all?"*

WSS Project Manager: "*We don't build dirty hacks here. The code must be maintainable.* [Takes the mouse cursor to highlight a database schema on the wiki page projected on the wall] *That would be our concept of this. That's a clean concept. I think you all agree that a replace mechanism would be a dirty concept, don't you?*"

SBS Software Architect: *"We agree, but our customers cannot wait two years for you to build a clean concept. Hence I'd say phase 1) make it 'good enough' in two months and phase 2) build a clean concept in two years."*

WSS Project Manager: *"But that concept will be clean in two months."* [Vivid discussion]

WSS Software Architect: [stands up, walks to the whiteboard, draws two containers labeled C1 and C2] *"The question is really simple: what will be part of component 1, and what will be part of component 2?"*

SBS Software Architect: [stands up, joins his colleague, draws a deployment diagram around C1 and C2]: *"When I said we do not want a replace mechanism I meant that here in this part* [points to the drawing] *we do not want a replace mechanism. My question was where you want to build this. As long as you keep that in C1 it's okay."* [Both agree]

SBS Project Manager: *"Can you please add that drawing to the wiki page, because when we read your solution proposal without that picture we did not understand it."*

[From field notes]

This whiteboard discussion shows us vividly how a tensed conflict between two parties can be resolved by co-creating an artifact to align mental models. The wiki page with the textual and tabular specifications failed to transfer important knowledge from one team to the other. Although the wiki page was projected on the wall and visible for everyone, only the head of project team 1 sitting on the PC could contribute to it. It was only when the two software architects turned to the whiteboard to discuss the component modifications synchronously that they were able to resolve the conflict,

establish a shared language and thereby maintain a shared understanding of the problem at hand. Photographs of such drawings are then often put on intranet wikis and used to anchor further discussions, especially in meetings where they are commonly projected on a screen to be reasoned around. We often observed that such illustrations are commonly hung up in the offices and hallways as anchor for further discussions (cf. figure 2).

Figure 2-2 : – Two software architects reasoning around printouts of diagrams. The printouts show the target picture for a new system's architecture.

Often times, aligning mental models requires not a single artifact, but a combination of many. For instance, in an early stage of the mobile banking suite project, the project team created software diagrams using standardized modeling notations such as UML or BPMN to create a shared understanding. One may assume that this approach is typical and valid in a software project. For such diagrams to be effective, however, all collaborators need to understand the notation, which customers or non-technical collaborators often do not. When the project team discussed the software specification with the customer, the feedback was not as expected.

> *"In general, actually, feedback only comes when they see it graphically in front of them. Most of our customers cannot imagine what it means when they just read text. A (software) specification does not help much there."* [i1, Software Architect, BITS].

The project team therefore proceeded to discuss the early ideas with a group of interaction design specialists. From the software specification, the more technically versed designers created a set of wireframes, i.e. rough schematic representations of UI screens that assimilate line drawings, and used these to perform a walkthrough of a typical financial advisory encounter with a customer. This team learned that wireframes were a more effective instrument to discuss the raw ideas and get an overall impression whether the proposed system could be helpful in practice.

However, the wireframe-based approach also had downsides. The project team had to learn that exemplary screens should be used with caution when they used wireframes in one workshop to present how the app could visualize a user's financial portfolio. As a seemingly illustrative example, the screens showed the exemplary use case of a user financing a house. The customer, a private bank manager, protested heavily that this would not even be a real use case for their customers since these could buy themselves a house anyways. Although in practice it would make no difference whether the customer buys a house or optimizes cash flows with the app, this led to lengthy, non-conducive discussions. Therefore, in a subsequent step, the team created a software prototype to overcome this challenge. One participant describes a positive experience with the software prototype in communication with customers:

> *"The prototype (still only) visualized a portfolio in simple pie charts. But it was insofar helpful as the customer could see 'ah, that's how it could look like.' The sole looking and touching helped (the customer) to understand what we wanted to show."* [i1, Software Architect, BITS].

In sum, aligning mental models allows individuals as well as groups to readjust their understanding of the idea at hand. When it is crucial to bring different people into alignment, artifacts facilitate preserving an idea's integrity in different contexts through adhering to a shared language. These artifacts maintain coherence and create a shared understanding across technical, functional, and organizational boundaries, thereby allowing people at those boundaries to align mental models.

Interpretation: Boundary Objects in Digital Innovation Practices

Aligning mental models is a fundamental practice to facilitate the process of organizing and coordinating innovative work. Here, artifacts bridge communication when people across technical, functional or organizational boundaries are involved. We observed how artifacts can help to collect feedback and bring a group into alignment. For instance, the above described whiteboard discussion triggered the creation of an artifact that facilitated coordinating future actions.

Interpreting the practice of *aligning mental models* through the pluralist object framework reveals that innovators use artifacts to construct boundary objects. A boundary object is defined by its ability to develop and maintain coherence across intersecting social worlds (Star & Griesemer, 1989). It needs to be both flexible and robust enough to act as translational and transformational device among different stakeholders. Examples for boundary objects from our case study include the UI screens, PowerPoint slides, handwritten sketches, and prototypes that innovators used to create a shared understanding among involved stakeholders. For instance, the above described whiteboard discussion showed that simple handwritten sketches with boxes and arrows can be much more effective than formal specifications with text and structured diagrams, such as UML or BPMN models. Despite the availability of numerous visual editors, many participants describe whiteboards as more efficient, lightweight, and easy-to-use drawing tools to create boundary objects. The structure of these boundary objects is sufficiently loose to allow for interpretive flexibility among various observers who enact and appropriate the underlying artifact. Yet, these boundary objects incorporate a certain degree of robustness to provide a shared language through which different groups develop a shared understanding.

Our analysis of boundary objects in digital innovation practices reveals that knowledge is not confined within or between people, but also embedded in the material environment that surrounds people. As we learned from our case study, innovators at BITS and CustomSoft coordinate work by placing ideas, thoughts, and knowledge on boundary objects, here represented as whiteboard sketches, printed diagrams on the wall, or software prototypes. When the project teams at BITS and CustomSoft needed to exchange highly specialized and distributed knowledge, these boundary objects helped to bring groups into alignment, develop a shared understanding of a problem, and then pass crucial information from one locus to another. Through their tangibility, these boundary objects made collaboration possible among different groups and support innovators in organizing their collaborative

discovery along the innovation trajectory. In this context, it is also often necessary to identify and resolve conflicts, which will be the focus of the following section.

2.4.3 Practice 3: Negotiating Solution Paths

Case Vignette 3: Identifying and Resolving Conflicts in the Web Self-Service Project

Anna is the Lead Software Architect for the Web Self-Service (WSS) project. The project is currently not going very well. What keeps Anna up at night is that her team struggles with dependencies on outdated legacy software components for which workarounds have to be built manually. This causes severe delays and susceptibility to errors in the development process. Anna is convinced that, if the team continues that way, the final software will be late, buggy, clumsy, and hard to maintain, if it can be delivered at all. In her view, the WSS prototype needs a radical overhaul. In a coffee break, she talks to WSS Project Manager Ben about her idea to take a Model-Driven Software Engineering (MDSE) approach in order to order to guarantee consistency of architectural patterns in the WSS product. Much to her surprise, Ben is anything but excited about her proposal. The project being behind schedule concerns him since long time anyway and hearing yet another half baked idea filled with technical nitty-gritty is the least thing he wants. "Why do these technical people always have to come up with new ideas when we are not even close to realizing the old ones yet?", thinks Ben. He takes Anna's idea for technical gold-plating of a solution that does not even meet the basic requirements for the original problem, yet. But Anna does not give up that fast. In the following two weeks, she works every minute of her spare time to successfully build an MDSE prototype that can exemplarily illustrate the project's most important use cases. After that, she immediately summons a management meeting to demonstrate her approach. But this time, she is much better prepared. She focuses her presentation on the business benefits, namely lower development cost, faster project goal attainment, and overall better technical maintainability. While the audience generally gives positive feedback, Ben points out that this approach can only be successful if the final product is also highly user-friendly for non-technical people. They summon another workshop to develop a solution for the usability problem, but Anna is happy anyway. The important thing is that they now pull in the same direction.

The third practice, *negotiating solution paths*, has the goal to narrow down the possible solution space and agree on actions to take in order to approach a problem at hand. This includes illustrating and selecting solution options to reach a consensus on further actions. In this practice, groups of innovators typically project their different views, goals, and interpretations into the solution space. Here, artifacts function as means to unify these diverse and sometimes conflicting viewpoints into a shared object of discourse.

From studying BITS and CustomSoft, we observed that innovators intentionally use artifacts to demonstrate an idea's desirability and feasibility. By showing instead of telling the envisaged benefits, artifacts help transgressing the many quality gates associated with digital innovation, be it to get skilled engineers to collaborate, to persuade managers of a funding decision, or to convince potential customers to adopt the envisaged innovation. For instance, one participant reported about an internal process innovation she initiated as part of the standard banking suite project in order

to improve business process modeling and standardization. In that case, she managed to convince the responsible project team of accepting her idea using a MS Excel-based decision matrix, which illustrated the possible solution paths, each with pro and contra arguments. In a workshop, each project team member had to assign score to the solution paths, resulting in a sustainably solid (and documented) decision on further actions. She reflects on this experience as follows:

"*It all depends on the result I want to achieve: do I want a decision or only feedback? If I want a decision, I (am) quite careful about the preparation, because I have learned that I am only successful when I adequately illustrate what I want to achieve. (…) In my experience, the content can be really genuine, but if I present it badly and miss the first shot, the topic is over. Hence, when the topic is important to me, I prepare my artifacts very carefully, be it a PowerPoint, be it that decision matrix, or be it a (wiki) page.*" [i8, Manager, BITS]

This participant points to the importance of using well-prepared illustrations when negotiating solution paths. If the artifact illustrates the important arguments in a clear way, and relevant stakeholders are able to bring in their opinion, it tends to be easier to find a consensus. Consider the following statement, where a project manager of the Web Self-Service project recalls a rather unsuccessful steering meeting:

"I recently learned that you already have to illustrate everything in an abstract on the first slide. Even in PowerPoint you need a management summary, because often times you don't even pass the first slide." [i6, Technical Lead, BITS]

This participant acknowledges that a management summary with a concise problem statement and the main contribution in few sentences would have made it easier to find a consensus. At first, the project team was stuck for quite a while because the team could not solve some wicked problems with the relatively new model-driven software engineering frameworks that were used. Customers and BITS management already began to fear that the product could eventually not be delivered. It was only when one software architect took the initiative to create a software prototype that showed, instead of told, what benefits the envisaged idea will deliver.

"I really had to put myself in front of the screen for two weeks to produce some code, more or less day and night. But eventually we had a (software) prototype that we could discuss." [i31, Technical Lead, BITS]

For this participant, a software prototype played an important role in persuading others and transgressing the many quality gates associated with digital innovation. Particularly the more technically versed employees (who make up the vast majority at BITS and CustomSoft) often struggle with finding the right arguments to persuade important decision makers of an idea. For this reason, managers at BITS and

CustomSoft consistently point to the importance of challenging the employee. In their view, many "techies" lack the business know-how to formulate out the benefit of an idea. Many discussions would be too technical and center on solutions that do not clearly address a real world problem. In their view, the main hurdle was not the company's willingness to support innovative employees, but rather a lack of skills to take personal risk from the employees' side. Asking tough questions would be the best approach to test the idea's substance and the employee's commitment to it, as a senior manager summarized:

> *"The usual point of failure is when the employee has started, then is allocated again to another project and does not have time anymore, and hence the idea peters out after a few attempts. [They may even have created some] presentation and everyone asks 'whew, that was all?' At that point, everyone has lost interest and the employee lost motivation. Hence you must ensure that he who [wants to do] something is responsible and really keeps saying: 'I want that, [I will] invest my personal money for that and I would even bet my bonus on that.'"* [i24, Senior Manager, BITS]

This participant points to the importance of making ideas visible, along with who is responsible, in order to allow others to ask the crucial questions and ensure the employee is still motivated. For this purpose, both BITS and CustomSoft maintain designated idea wikis. The CustomSoft idea wiki is an open platform where all employees can submit, view, edit, and comment on ideas. There, employees can enter ideas using a fact sheet template with predefined sections. After an informal screening process of group discussion, the innovators are requested to submit more elaborate artifacts such as a five minutes' video presentation, a one-page poster, a rough business plan, a business model canvas, or a prototype. All employees are allowed to use a few working days to initiate an idea site, and blue-sky thinking ideas are explicitly encouraged. The start page features an activity stream, depicting the ideas to which members contribute frequently. In addition, the CustomSoft innovation board uses the idea wiki to track a project's status. This would also contribute to employee motivation and satisfaction:

> *"Our [idea wiki] is an important instrument. When someone posts an idea there, I always try to at least like or comment it. That's an encouragement aspect."* [i93, Senior Manager, CustomSoft].

In contrast to CustomSoft's open idea wiki, the BITS idea wiki is a rather closed platform where only administrators publish information about those selected ideas that have been presented at the idea fair, and ideas typically relate to a previously

predefined area of the company's strategy. Here, an idea wiki page contains a 5-minute video presentation, the poster, additional information in text, and a comment function.

In sum, negotiating solution paths allows people to iteratively narrow down the solution space. When it is crucial to agree on necessary further actions, artifacts facilitate targeted discussions by unifying the different views and interpretations of relevant stakeholders through their emergent, fragmented, and unfinished nature.

Interpretation: Activity Objects in Digital Innovation Practices

Negotiating solution paths is a fundamental practice where people negotiate how a problem can be approached, and what consequences would result from walking down the envisaged solution path. It can be seen as an iterative communication and decision-making practice in which innovators search for a consensus on further actions. Here, we observed that an artifact can be used to ground judgments of the potential benefit and feasibility of a solution. At BITS and CustomSoft, innovators commonly used artifacts as a means to propagate an emerging idea, to support complex decisions, and to transgress the many quality gates that are associated with digital innovation. As people project their various skills, perspectives, and concerns into this solution space, they are able to negotiate ideas and reach a consensus. This joint decision-making and negotiating practice entails communal persuading and gatekeeping whereby involved innovators commonly use artifacts as a reference or prospect for the envisaged solution.

Interpreting the practice of *negotiating solution paths* through the pluralist object framework reveals that innovators use artifacts to coordinate their collaborative discovery around activity objects. While boundary objects are essential to facilitate collaboration and create the scaffold around which innovators bring their mental models into alignment, activity objects can also be used to actively push boundaries and negotiate solution paths. Unlike boundary objects, which can preserve an idea's integrity in different contexts, activity objects are necessarily partial pieces of a puzzle, elusive for any of the involved collaborators, and they require discourse and mutual adjustment of conceptions. Innovators at BITS and CustomSoft negotiated solution paths in a creative way by identifying and resolving conflicts with artifacts, be it a well-prepared decision matrix in excel, a management summary in PowerPoint, a prototype discussed in a workshop, or an idea wiki. Such activity objects share some commonalities with epistemic objects in that they both direct practices and motivate collaboration through their unfinished nature. But in addition to that, they can be seen as shared problem spaces into which people project their various perspectives to negotiate an object or objective (Nicolini et al. 2012).

2.4.4 Practice 4: Crafting an Idea

Case Vignette 4: Developing the Mobile Banking Suite

Everything is set for the Mobile Banking Suite (MBS) project to take off. The concept is sound, the goals clearly defined, the funding and personal resources are granted. Now it is time to put the plan into practice. This is the moment when Carl and Denise, two experienced Software Engineers with a can-do attitude, enter the stage. Among colleagues, Carl and Denise are known for their very persistent, not to say a bit quirky, attitude when it comes to developing new products. They usually immerse themselves deeply with whatever they are working on by blocking fixed 'flow time' slots in their calender. During these slots, they completely set their programming environment on full screen mode, turn off all communication channels (mail, chat, phone, etc.), they do not attend any meetings whatsoever, and colleagues are urged to interrupt them only in very important cases. They even close the window shutters and remove any possible distractions from their office. The only time they actually leave the monitor is to discuss solutions on the whiteboard.

In this fourth practice, *crafting an idea*, innovators employ measures that advance the process of idea materialization. This practice has the goal to execute the previously agreed upon actions in a targeted manner. From studying BITS and CustomSoft, we learned that the targeted execution of an idea stands and falls with the extent to which those who realize it are willing and able to master their craft. While we would readily confirm that most employees at both companies are creative and have many ideas, it is harder to estimate how many people have the necessary appetite and dedication to take the idea all the way to the end. One way participants at BITS and CustomSoft tend to think of execution is to compare innovative work with a craft:

> *"It is really simply a craft to understand: 'How do I achieve a certain goal with limited resources in manageable time?' [And to] recognize: 'This is an important question and that is an unimportant question; this is a solvable problem and that is an unsolvable problem.'"* [i78, Senior Manager, CustomSoft]

More often than not, crafting an idea is a non-linear process imbued with uncertainty and fear of failure, requiring experimentation, hacking, tinkering, and trying out what is possible in a given situation. We observed that innovators learn while they are in flow and make their way through the idea while executing it, sometimes referring to this practice as innovating-by-doing or trial-and-error. For instance, one member of the mobile banking project compares prototyping with Lego:

> *"You add one or two bricks, remove some others, refine a whole chunk, then start again with a new plate. […] The whole idea is only a sketch until you build a prototype and validate it with someone who has the business knowledge. But unless you create something tangible, you will never get to the next level."* [i10, Business Analysts, BITS]

This participant points to how the maturity of the presented artifacts influences the quality of the feedback that one can obtain. Here, crafting an idea required the project team to dedicate itself toward creating a sufficiently persuading artifact (in this case, a software prototype). Of course, this is only a part of the whole story. What is much more difficult to capture through after-the-fact interviews are the actual work practices behind crafting an idea. These practices are to a large extent mediated by a whole ecology of artifacts that people often note only subconsciously, if at all. This becomes much more apparent in the following field note from a participant observation at BITS:

"In the BITS office with the Web Self-Service project team, I follow a conversation between the team head T. and software developer M. who try to understand why the IDE (integrated development environment) keeps throwing a runtime exception at M.'s test environment who currently develops a central module. They open and argue around a wiki page that contains a whiteboard photograph that illustrates the target architecture of the module from last week's architecture workshop. M. has a conjecture where the problem may lie and walks over to the room's whiteboard to redraw the target architecture and the object lifecycle. They realize that the error must have been introduced with the last update in the persistence layer. T. quickly opens the code review system to inspect the changes that M. made since the last working version of the system. They go back to the whiteboard and revise the target business object design with an additional attribute and an adapted persistence process."

[From field notes; cf. figure 3]

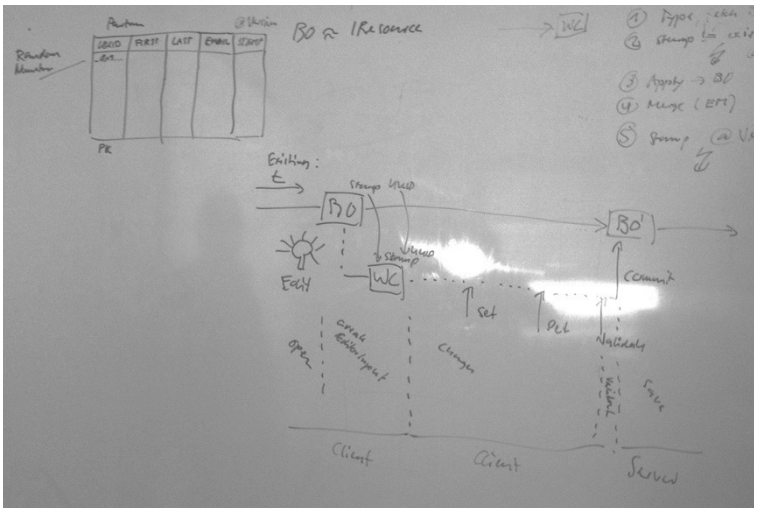


Figure 2-3 : Whiteboard sketch from an impromptu discussion in which two project members discovered how the software design and the business workflow had to be adapted.

The above situation shows what becomes visible if we explicitly address the subtle role of artifacts in digital innovation practices. Taken alone, the whiteboard, the wiki page, the IDE, the code review system, and the office room may seem insignificant. In fact, people usually use such mundane artifacts subconsciously, without explicitly reflecting about it. But without these mediating artifacts, crafting the idea would be very difficult. When we later interviewed the team head and software developer, they would not reconstruct the situation with all involved artifacts. In fact, only few participants would mention their IDE as an artifact in an interview since it is so deeply entangled in their everyday work. Only in the case of a breakdown, i.e. when the IDE did not work as expected, did the two participants start to consciously investigate the problem. Thus, addressing such artifacts explicitly helped us to shed more light on the process of idea materialization. Figure 4 provides an example of idea materialization from first whiteboard sketch to working prototype.

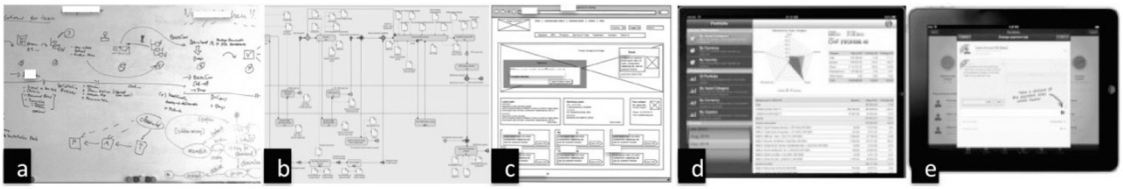


Figure 2-4 : Materialization of an innovation with artifacts at different degrees of maturity. a) Whiteboard sketch b) BPMN diagram, c) wireframe d) UI mockup e) iPad prototype.

In sum, crafting an idea is an important practice to advance the process of materialization. It depends crucially on the targeted execution by skilled individuals. It is a materially mediated activity in that design steps are tinkered and formed from the stack of resources at hand.

Interpretation: Material Infrastructure in Digital Innovation Practices

Crafting an idea describes how the development of innovative information systems emerges from the bottom-up enacted practices of individuals, out of hacking and tinkering. By allowing innovations to evolve from bottom-up, rather than controlling them through strategic planning from top-down, a company is able to end up with something original (cf. Ciborra, 1992). As such, crafting an idea sheds more light on how innovators use what is ready-to-hand and embedded locally, mobilizing existing digital and physical artifacts. By recombining and re-employing these artifacts at hand, people are able to craft innovative solutions for real problems. Innovative developments are often characterized by continuously considering what existing artifacts are available and then what can be developed within the boundaries provided by those assets (Leonardi, 2011). It is important to note that these assets can both afford and constrain innovation. Consider an architect who develops the blueprint for a new house that is to be built; the realization of the blueprint depends crucially on the artifacts at hand, such as cost and availability of local building material, environmental conditions, statics, contemporary architecture style, and the expertise of skilled workers. That being said, it comes evident that innovative developments are a matter of crafting ideas in a targeted manner.

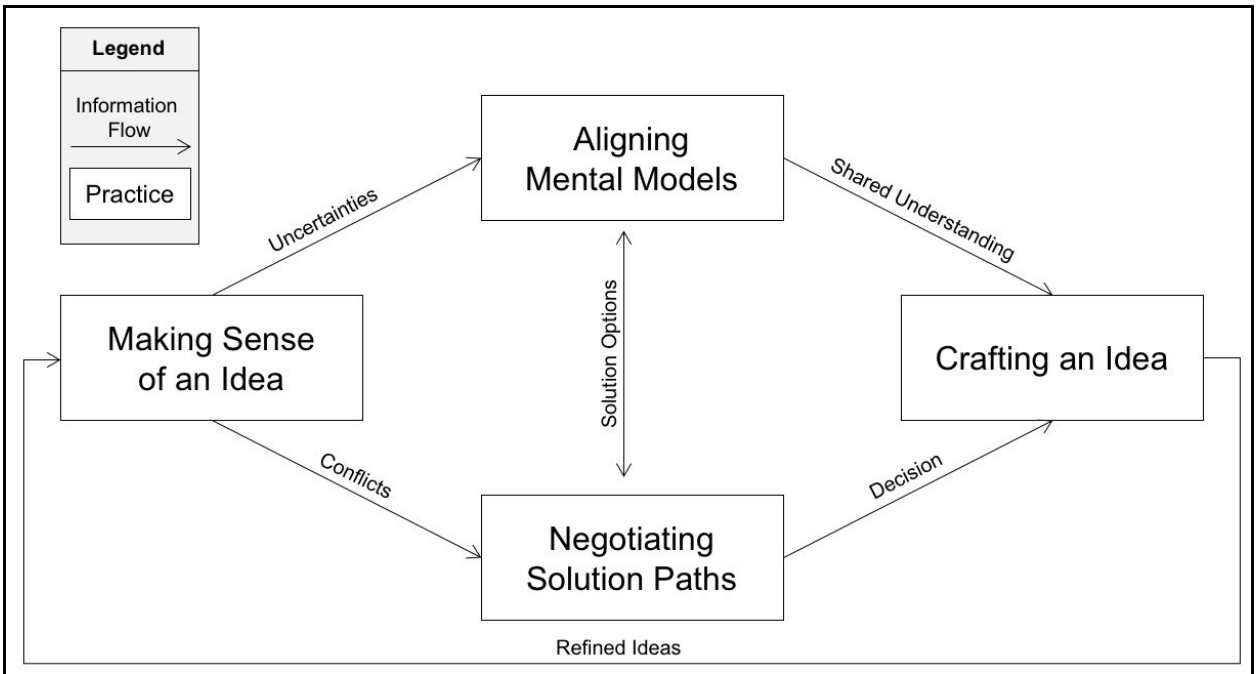
The reason why we use the term *craft* here is that, according to our deepening understanding of innovation practices at BITS and CustomSoft, we realized that the main barrier to innovation was not a lack of promising ideas, but rather the targeted execution of the most promising ones. One aspect that left us dissatisfied with many related innovation studies was that they offered few insights into the actual work practices of execution. Whereas inability to execute is a well-known barrier to innovation (Wessel, 2014), execution itself is often treated as a black box. Given the unique opportunity to closely collaborate with two companies, our goal was to open this black box and shed more light on the actual work practices by revealing the role of artifacts.

The material infrastructure lens (Nicolini et al., 2012; Star and Ruhleder, 1996) helps to understand the practice of crafting an idea. Material infrastructure remains subtly, yet importantly, in the background and people often to not even consciously note that they it. In digital innovation practices, however, the absence of the material infrastructure, composed of whiteboards, laptops, screens, integrated development environments (IDEs), wikis, office rooms, would make it next to impossible to create further artifacts that may once function boundary objects, activity objects, and

epistemic objects. It is therefore helpful to explicitly embrace various kinds of artifacts in an analysis of innovation practices.

2.5 Discussion

2.5.1 A Practice-based Model of Digital Innovation



Making Sense of an Idea Goal: Reach a clearer understanding of the idea Role of Artifacts: Epistemic Objects	**Aligning Mental Models** Goal: Develop a shared understanding Role of Artifacts: Boundary Object
Negotiating Solution Paths Goal: Narrow down the possible solution space Role of Artifacts: Activity Object	**Crafting an Idea** Goal: Advance idea materialization Role of Artifacts: Material infrastructure

Figure 2-5 : Practice-based Model of Digital Innovation

In the previous section, we provided rich insights into the digital innovation practices at two Swiss software companies. Our results confirm that innovation practices are increasingly characterized by network-centric (Chesbrough, 2003), employee-driven (Desouza, 2011), and digital technology-based (Yoo et al. 2010) work structures. This requires groups of innovators with various specializations to work together across boundaries using various artifacts - which is challenging, particularly when creating novelty (Majchrzak et al., 2012). Placing a stronger focus on artifacts helped us to foreground the actual innovation practices. In doing so, we have identified and conceptualized four *practices through which people enact digital innovation*,

relating to the first research question of this paper. Namely, people make sense of ideas, align mental models, negotiate solution paths, and craft ideas in the context of digital innovation.

The conceptual model in figure 5 sets the four practices in relation to each other. Innovators strive for a clearer understanding of an idea by constructing epistemic objects when *making sense of an idea*. Thereby, they identify uncertainties (e.g. open questions or issues that need clarification) and conflicts (e.g. different and mutually exclusive possible viewpoints, competition for resources). These flow into *alinging mental models* and *negotiating solution paths,* respectively. In the former, stakeholders that are involved in the innovation endeavor develop a shared understanding by constructing boundary objects. In the latter, the innovation teams narrow down the possible solution space and agree on necessary actions by constructing activity objects. In both practices, innovators identify and mutually exchange solution options, whereby the output of *alinging mental models* is a shared understanding of and the output of *negotiating solution paths* is a decision on these, respectively. Both outputs flow into *crafting an idea*, where innovators employ necessary measures to advance idea materialization by transforming the available material infrastructure in a targeted manner. In a learning by doing fashion, the innovator thereby obtains refined ideas, which again flow into *making sense of an idea*, where the whole process starts anew.

2.5.2 Implications for Research

The practice-based model of digital innovation furthers existing knowledge in that it foregrounds the bottom-up emergence of digital innovation practices from artifact-based viewpoint. It specifies a set of digital innovation practices and illustrates the requirements for which to design social and technical innovation support. IS scholars with an interest in understanding and improving digital innovation may draw on this contribution to better understand the environmental conditions under which artifacts play different roles that require different supporting measures. The goal should be to analyze and design artifacts to meet the respective requirements of the underlying practices.

Taken together, these four practices form an iterative and incremental cycle that describes the bottom-up emergence of digital innovation. This is in stark contrast to the linear process perspective on innovation that prevails in existing innovation management literature and provides models with linear, sequential, and consecutive phases (e.g. Chesbrough, 2003; Desouza, 2011; Fichman et al., 2014; Tidd and Bessant, 2011; cf. section 2.1). In practice, the phases usually overlap and the interdependencies

are much more complex than they appear in the linear path models of the linear process perspective. In the lived experience of those who actually practice innovation, the sequentially consecutive phases are interconnected in a complex manner. The here presented practice-based model of digital innovation describes an innovation process that is much more open-ended, emergent, and serendipitous. Innovators can enact the four practices in any of the phases described in the classic innovation management literature. This frames digital innovation as an artifact-mediated human practice with alternating sequences of individual practices and group practices involving continuous learning, improvisation, and trial-and-error.

The suggested practice-based model of digital innovation offers a nuanced perspective that embraces the changing roles of artifacts and the conditions under which such changes take place. This directly addresses Nicolini et al.'s (2012) call to research not only the plural role of artifacts, but also the contextual factors that trigger transitions in their role. Namely, depending on whether the current situation requires making sense of an idea, aligning mental models, negotiating solution paths, or crafting an idea, the same artifact may change its role back and forth between epistemic object, activity object, boundary object, and material infrastructure, respectively. The provided interpretation of each practice focuses on this changing role of artifacts and thereby relates to the second research question in this paper, namely *what role do artifacts play in digital innovation practices?*

Our study provides thought-provoking impulses for scholars interested in enabling digital innovation in organizations. The practice-based model foregrounds that one single view on artifacts does not suffice to understand how various artifacts mediate and facilitate digital innovation practices differently. Rather more, a nuanced understanding of the multifaceted constellations of people, practices, and tools is necessary to allow digital innovations to emerge. Digital innovation implies the need to structure the emergence of innovative digital products through the targeted application of artifacts in appropriate practices, leading to increasingly combinatorial and distributed innovation practices (Yoo et al. 2012). Innovation teams need to be aware of the underlying digital innovation practices to be flexible and adapt to ever faster-changing requirements in the digital age. Organizations with an interest in enabling digital innovation may help employees to participate in the innovation process by providing an environment where employees can enact these practices with readily available artifacts at hand. Hence, we suggest future research to also think of the broader shift in perspective, namely from managing and controlling top-down

specified innovation processes towards facilitating and enabling bottom-up emerging innovation practices.

Our study suggests that managing digital innovation means a radical departure from classical IT project management approaches, which mostly rely on project management methods that are not specific to IT (cf. Yoo, 2013). By injecting digital artifacts into innovation practices, the practices themselves inherit characteristics of digital artifacts, such as programmability, traceability, and malleability (Yoo et al. 2010). Hence, we need novel management approaches that embrace the unique characteristics of digital artifacts and the numerous possibilities they provide (Yoo et al. 2010). We contribute to this ongoing discourse in IS literature by helping to understand the important role of practices and artifacts in digital innovation. The outcome of digital innovation projects depends crucially on how people are able to enact the practices of *making sense of an idea, aligning mental models, negotiating solution paths,* and *crafting an idea* through the targeted modification, application, and recombination of digital and physical artifacts. In doing so, our study also sheds more light on the role of creativity and innovativeness in practices, which is still an underexplored topic (Eppler et al., 2011; Nicolini et al., 2012).

In sum, we suggest future digital innovation research not only to appreciate the unique characteristics of digital artifacts, but also to understand digital artifacts-in-use and how people enact them in the underlying innovation practices. Innovating in the digital age requires us to better understand the process of digitalization, unfolding through the continuous production and reproduction of artifacts. While this corresponds to previous research indicating that the digitalization of the analog has important implications for the innovation process itself (Yoo et al., 2012, 2010), our study shows that digital innovation is also a human practice mediated by both digital and physical artifacts. Any study of digital innovation practices should carefully examine the interconnected role of physical and digital artifacts in parallel.

2.5.3 Implications for Practice

Ever more companies place a stronger focus on innovating and thereby face various new opportunities but also new challenges (Tidd and Bessant, 2011). On the organizational level, companies struggle with shortened product cycles and high demands on time to market (Christensen, 1997), increased competition through globally networked alliances (Chesbrough, 2003), and last but not least strong competition for skilled and creative employees (Desouza, 2011). On the individual level, this increases the pressure on employees to act entrepreneurial within the

boundaries of their organization, which involves breaking free from established thinking patterns, dealing with high degrees of uncertainty, and overcoming resistance to change (Desouza, 2011). Despite the wide diffusion of literature suggesting best practices, innovating remains a major challenge for companies, and the nearly limitless possibilities offered by new digital artifacts do not make that task any easier (Yoo et al., 2012, 2010).

Through our deep insights into the digital innovation practices at two Swiss software companies, we were able to provide these companies with the opportunity to reflect on and improve their own innovation practices, and to understand how certain combinations of people, practices, and artifacts led to innovative outcomes. Part of our contribution is to condense these rich insights in a way that makes them transferable to a broader class of companies who share common basic assumptions with our two case companies (Walsham, 1995). These include companies that encourage employees to innovate and engage in cross-disciplinary IS development, such as software companies, but also large enterprises with designated software development branches, such as banks, car manufacturers, or telecommunications providers. Our study illustrates ways in which companies can support employees to better realize ideas on the one hand, and provides examples how employees can execute the necessary steps on the other hand. Our practice-based model of digital innovation provides a starting point for designing social and technical innovation support, and for analyzing why many well-intentioned innovation management approaches do not automatically result in well-executed innovation practices.

Recent studies point to the increasingly important role of the employee as a driver for innovation in organizations (Desouza, 2011). Against this backdrop, our contribution allows managers of innovation teams to identify people with different personal characteristics. For instance, one may characterize a person who is particularly strong in the individual practices making sense of an idea and crafting an idea as a *lone genius*, that is someone who is really good at carving out ideas individually, but lacks the communication and collaboration skills to align mental models with others and moderate the negotiation of solution paths. On the contrary, one may characterize a person who is quite strong in the group practices aligning mental models and negotiating solution paths as a *process facilitator*, that is someone who is good at communicating and coordinating ideas but lacks the dedication and (often rather technical) skills to execute an idea individually. This classification integrates well with recent studies that indicate the existence of two clearly distinct types of individuals in innovation processes, namely innovators and innovation

catalysts (Tortoriello et al., 2014). Managers should consider combining a good mix of these different characters when assembling innovation teams. In turn, team members should consider carrying out a self-critical assessment based on the four practices, identify their own strengths and weaknesses, and search for individuals that complement them (cf. Desouza 2011).

2.6 Conclusion

This paper explores digital innovation practices from an artifact perspective, focusing on the practices of employees who actively promote ideas. Drawing on an in-depth case study at two Swiss software companies, we focus on how innovators use artifacts to practice digital innovation. Our analysis shows how employees choose from a variety of digital and physical artifacts, depending on whether they pursue a clearer understanding of an idea for themselves, create a shared understanding among relevant stakeholders, negotiate solution paths to narrow down the possible solution space, or advance the process of idea materialization through targeted execution of necessary actions. In this regard, this paper specifies artifact use practices in an innovation context and, thereby, clarifies the role of artifacts in digital innovation practices. In times where digital artifacts play an increasingly important role and gain growing research attention (Yoo et al., 2010, 2012), one should bear in mind the major role of (digital and physical) material objects and how they mediate social interaction (Nicolini et al., 2012).

The present study contributes a practice-based model of digital innovation to that discourse. This model helps to understand the bottom-up emergent nature of digital innovation in a corporate environment, enacted in the individual practices of employees; it specifies the conditions under which artifacts change roles; it provides rich insight into how people enact digital innovation practices with artifacts; it clarifies the role artifacts play in digital innovation practices; and it provides a practical example of how the pluralist object framework by Nicolini et al. (2012) can be applied to analyze the role of artifacts in various practices.

We conclude this article by raising some interesting questions for future work. With this study, we identified and conceptualized a set of digital innovation practices, namely *making sense of an idea, aligning mental models, negotiating solution paths,* and *crafting an idea*. For this purpose, we chose qualitative methods and inductive theory building to identify and describe the concepts and their interrelations. Further quantitative work could develop metrics to measure the suggested interrelations and their relative effect sizes, for instance in laboratory experiments or with surveys. We

focus our study on digital innovation practices in and around two software companies that are both culturally innovative organizations, yet not necessarily leading edge. Further research could determine whether the practices we identified are found in other contexts and conditions. In this study, we see digital innovation practices through an artifact lens and provide rich insights into the actual interactions between people and artifacts. Whereas these insights offer possibilities to deeper understand digital innovation practices, they alone do not offer comprehensive prescriptions on how these practices should be supported ideally. Further research could build on this contribution and examine how leading innovative companies engage in these four practices to identify best practices and structured guidance for innovation.

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3 PowerPoint Paradoxes in Digital Innovation Practices

(WORKING PAPER)

Raffaele Fabio Ciriello, Alexander Richter, Gerhard Schwabe
University of Zurich, Binzmühlestrasse 14, 8050 Zürich, Switzerland
ciriello@ifi.uzh.ch, arichter@ifi.uzh.ch, schwabe@ifi.uzh.ch

This paper is currently in preparation for journal submission. It builds on a previous publication, named "PowerPoint Use and Misuse in Digital Innovation", which has been published in the Proceedings of the 23rd European Conference on Information Systems (ECIS2015), Münster, Germany

Abstract: PowerPoint is an indispensable component of modern business communication, implying a growing need to better understand its role in different contexts. Whereas many studies have examined effects of using PowerPoint in one specific setting, the ambivalent user experiences afforded by PowerPoint-specific characteristics are often overlooked. This paper contributes to this gap by theorizing PowerPoint's dual role in the context of digital innovation. Through a dialectical synthesis, grounded in qualitative field data from two software companies and related literature, we identify three 'PowerPoint Paradoxes', i.e. conflicting yet interrelated ambivalences that co-exist over time in different PowerPoint practices: 1) *Freedom* and *Captivity*, 2) *Clarity* and *Ambiguity*, and 3) *Scarcity* and *Abundance*. Moreover, we identify three corresponding ways of coping with these paradoxes. Thereby, this paper extends PowerPoint literature by describing phenomena that result from using PowerPoint in an underresearched context, namely digital innovation. Our contribution further extends digital innovation literature by illustrating the ambivalent effects of using PowerPoint as an idea communication tool.

Keywords: PowerPoint, Paradox, Practices, Digital Innovation, Artifact, Affordances, Case Study, Grounded Theory

3.1 Introduction

PowerPoint has become indispensable in today's businesses around the world (Parks, 2012). Due to its characteristics, such as malleability and flexibility, PowerPoint is no longer used solely as a presentation tool, but also to support a variety of different practices, such as brainstorming, documentation, modeling, or even prototyping (Yates and Orlikowski 2007, Schoeneborn 2013). Existing PowerPoint studies focus either on technical properties of PowerPoint or on the (often negative) effects of using it in one specific setting, usually business presentations. Other related studies (e.g. Carlile, 2002; Nicolini et al., 2012) mention in passing the use of PowerPoint in various practices without further investigating the important impact of its use. This view limits our understanding about the role of PowerPoint in practices that go beyond the classical use for facilitating presentations. PowerPoint does not prescribe narrowly defined work practices and, thus, its (positive or negative) effects have to be studied with regard to the context in which it is used (cf. Fichman et al., 2014; Leonardi, 2011; Orlikowski, 2007; Riemer and Johnston, 2014). One of the recently most important yet underresearched contexts is digital innovation, where PowerPoint is widely used with far-reaching consequences. This paper examines PowerPoint practices in a digital innovation context through an over two year-long, in-depth qualitative field study in two software companies.

Our research approach was as follows. Through an in-depth case study, which we conducted inside two major European software companies over a period of more than two years, we could examine and participate in practices related to the development of innovative software products. From this relationship, we obtained a deep understanding of the many tensions involved when using PowerPoint in digital innovation practices. Collecting an extensive data set, consisting of 95 interviews, 41 slide decks, and 216 days of participant observation, and analyzing the data with grounded theory inspired methods, we learned that PowerPoint's beneficial and detrimental effect cannot be regarded in separation. This became the focus of our analysis, in which we address the research question: *What role does using PowerPoint play in digital innovation practices?*

The contribution of this paper is twofold:

1) *Understanding the Role of PowerPoint in Digital Innovation Practices:* Researchers and practitioners interested in PowerPoint's role in different organizational and communicational practices (cf. Kernbach et al., 2015; Schoeneborn, 2013; Yates and Orlikowski, 2007) can learn about the surprising phenomena and tensions that arise from using PowerPoint in a novel and underresearched context, namely digital innovation. This paper provides a dialectical synthesis of the contradictory ambivalences (i.e. paradoxes) that innovators experience when using PowerPoint, and shows how innovators cope with these paradoxes. Thereby, this paper extends the ongoing PowerPoint discourse (section 2 provides an overview) in that it theorizes PowerPoint paradoxes in digital innovation practices.

2) *Understanding the Use of IT Artifacts for Communicating Ideas in Digital Innovation:* Researchers and practitioners seeking to understand how technical characteristics of IT artifacts support knowledge-intensive work practices in digital innovation (cf. Yoo et al., 2010) get an opportunity to critically reflect on the characteristics of an arguably dominant innovation tool - namely PowerPoint - and how innovators use it. Essentially, this paper presents a set of PowerPoint practices that help to better understand how and why people use IT artifacts like PowerPoint for communicating ideas. Innovators and innovation managers can use the here presented PowerPoint practices as a guideline to understand how using PowerPoint can support their practices. Thereby, this paper sheds more light on the actual practices of innovative employees in two software companies and contributes a practice-based perspective to the discourse on the use of IT artifacts in digital innovation (section 2.2 provides an overview).

The remainder of this paper is structured as follows. We start with the theoretical foundations in section 2 by advocating a practice lens on digital innovation, summarizing the current state of the PowerPoint debatedefining the distinctive features of PowerPoint, and introducing the paradox lens we adopt to interpret our results. We then give detailed insights into our research approach in section 3, providing context of our in-depth interpretive case study of digital innovation practices at BITS and CustomSoft, and illustrating our use of grounded theory methodologies to theorize PowerPoint Paradoxes. Section 4 then presents our results, namely three PowerPoint Paradoxes and ways of coping with these. What follows in section 5 is a theoretical

integration and discussion of the implications of our study. We conclude by summarizing the key takeaways and pointing to areas of future work in section 6.

3.2 Related Literature

3.2.1 Role of IT Artifacts in Digital Innovation Practices

Digital innovation, i.e. carrying out new combinations of physical and digital components to produce novel products, processes, and business models enabled by or embodied in IT (Fichman et al., 2014; Yoo et al., 2010), is an increasingly important, yet not sufficiently understood, phenomenon. Unlike traditional IT innovation, which focuses on stability and managing IT as commodity to exploit the existing business, digital innovation requires us to think of innovation as an increasingly people-driven (Desouza, 2011), network-centered (Tuomi, 2002), and digitalized process (Yoo et al., 2012). Thus, we need to embrace the flexibility and fluidity of digital technologies, like PowerPoint, to explore new forms of businesses (Gregory et al., 2015; Yoo, 2013).

According to Yoo, Henfridsson, and Lyytinen (2010), digital technology has three distinctively unique key characteristics that distinguish digital from non-digital innovation, namely reprogrammability, homogenization of data, and self-reference. According to these authors, reprogrammability means that digital technology enables devices to perform a variety of functions through a "*separation of the semiotic functional logic of the device from the physical embodiment that executes it*" (p.726). Homogenization of data refers to the capability to separate the content from the medium by allowing any digital content (e.g. audio, video, text, and image) to be stored, processed, and displayed (p.726). And self-reference means that digital technology requires the use of digital technology, which creates positive network externalities and "*fosters further digital innovation through a virtuous cycle of lowered entry barriers, decreased learning costs, and accelerated diffusion rates.*" (p.726). In conclusion, these authors argue that digital technology, through these key characteristics, „*has democratized innovation and almost anyone can now participate*" (p.726). In other words, creating facilitating conditions for employees to develop ideas is an essential prerequisite for digital innovation to emerge in a corporate environment (Desouza, 2011). As a developer or adopter of a given digital innovation, a person is a carrier of a practice. In turn, digital technology itself

exists only as technology-in-use, embodied in a specific practice. Accordingly, any innovation process, whether digital or not, can only unfold as a sequence of various practices. The appropriate level of analysis to capture the complexity of digital innovation is, therefore, at the level of practice (Tuomi, 2002) and how it is mediated by digital and non-digital artifacts (Orlikowski, 2007), like PowerPoint. Here, we understand practices as "*embodied, materially mediated arrays of human activity centrally organized around shared practical understandings*" (Schatzki, 2001, p. 2).

3.2.2 Current State of the PowerPoint Debate

PowerPoint is an indispensable tool for knowledge workers, with more than one billion installations, millions of slides produced every day, and several hundred presentations every second around the globe (Parks, 2012). Practical handbooks on using PowerPoint encounter considerable commercial success (e.g. Abela, 2008; Berk, 2011; Duarte, 2008; Roam, 2009). PowerPoint also encounters reception in popular culture, from humoristic comics (Adams, 2016) over 'PowerPoint Karaoke' contests (Knoblauch, 2008), up to critical voices that denounce PowerPoint's negative impact (Garber, 2001; Parker, 2001; Tufte, 2003). In recent years, a growing number of academics direct their attention to the phenomenon of PowerPoint and the far-reaching consequences of its widespread use.

To cite some prominent cases, data visualization expert Edward Tufte kicked off a heated debate on the use of PowerPoint following the fatal crash of NASA's space shuttle *Columbia* in 1996. Tufte (2003) argues that responsible engineers had documented threats to the Columbia in a PowerPoint-based technical report, where the crucial deficit that finally caused the severe accident remained inconspicuously on the fourth sublevel of a hierarchical bullet point list. In his analysis that follows, Tufte describes PowerPoint slides as dulling war propaganda and blames the inexpressive bullet point logic enforced by PowerPoint for the disaster. He argues that the distinctive, definite, well-enforced cognitive style of PowerPoint contradicts serious thinking and actively facilitates making lightweight presentations for whitewashing weak analyses with visual aids (Tufte, 2003). Follow-up studies examine the role of PowerPoint in strategy making (Kaplan, 2011), higher-level education (Gabriel, 2008; Knoblauch, 2008), and public demonstrations (Stark and Paravel, 2008). For instance, Stark and Paravel

(2008) ascribe PowerPoint a central role in Colin Powell's senate talk in 2003, through which the then US Secretary of State built the case for the invasion of Iraq. According to these authors, Powell's persuasive PowerPoint-assisted accumulation of maps and photographs overshadowed the validity of the facts, and also facilitated circulation of the digital document across the internet.

Hence not surprisingly, a considerable number of academics and practitioners demonize PowerPoint. For instance, renowned human-computer interaction researcher Clifford Nass reported on a case where he had to exclude a beloved book from a lecture, because he "*couldn't get the book into bullet points*" (Parker, 2001, p. 6). From this experience, Nass concluded that PowerPoint guides people to make the point, but because it focuses only on the outcomes, it makes it more difficult to convey the process of reasoning. Of comparable prominence are the cases of well-known executives who banned PowerPoint partly or completely from their companies. To give two examples: Co-founder and former Apple CEO Steve Jobs banned PowerPoint from the product review process, because he wanted people "*to engage, to hash things out at the table, rather than show a bunch of slides. People who know what they're talking about don't need PowerPoint*" (Isaacson, 2011, p. 366). And Amazon CEO Jeff Bezos obliges employees to write a six page narrative summary to present their idea, instead of starting with a PowerPoint presentation (Pfeffer Merrill, 2013; Rose, 2012).

In the ongoing heated debate, authors responded that such drawbacks should not be ascribed to the PowerPoint software itself, but rather to how it is used. For instance, Yates and Orlikowski (2007) describe PowerPoint's permeation of multiple communicational genres, such as project documentation and oral presentations, as a source of dissonant expectations and misinterpretations in organizational communication. Schoeneborn (2013) refines these theorizations by identifying subgenres and causes of this genre expansion. He concludes that social phenomena such as organizations and professions are continuously evoked in and through communication and its material manifestations, and not vice versa. In this vein, the author sees PowerPoint as constituting component in organizational practices.

More recently, Kernbach et al. (2015) provide a comprehensive literature review summarizing the current state of the PowerPoint debate. They divide the discourse into three phases, namely early criticism, heated debate, and scientific take-off. From the

analyzed studies, the authors extract a set of constraining qualities of PowerPoint presentations. While this provides a good overview of PowerPoint's technical properties that are important in a presentation setting, it falls short of important aspects when PowerPoint is used for other practices, such as for product documentation or as brainstorming tool.

In sum, most extant studies focus on the (often negative) impacts of using PowerPoint in one specific setting. Some other studies focus primarily on the technical properties of PowerPoint, but the relationship between PowerPoint's technical properties and its impact remains to be clarified. We see this paper into that line of studies as we examine the role of PowerPoint in digital innovation, which recently gains in importance for IS researchers and practitioners. Notwithstanding some studies have mentioned in passing the use of PowerPoint in new product development (Carlile, 2002), the existing literature currently lacks comprehensive insights into the role of PowerPoint in digital innovation. Following Tufte's (2003) seminal controversial analysis of PowerPoint's 'cognitive style', ever more scholars approached the pervasive use of PowerPoint applying various research methods, including ethnographic studies, surveys, or literature reviews (Kernbach et al., 2015). Recent PowerPoint studies originate from various disciplines, including sociology (Knoblauch, 2008; Stark and Paravel, 2008), pedagogy (Adams, 2006), or organization studies (Gabriel, 2008; Kaplan, 2011; Schoeneborn, 2013). However, except for Yates and Orlikowski's (2007) well cited analysis of PowerPoint, the information systems (IS) community has not yet yielded significant contributions to that discourse. This is surprising, given that IS researchers, particularly those who are interested in the relationship between technology-in-use and human action in organizational practices, are predestined to obtain a deeper understanding of the underlying practices in which digital artifacts, such as PowerPoint, are embedded (cf. Fichman et al., 2014; Leonardi, 2011; Orlikowski, 2007; Riemer and Johnston, 2014). Thus, we know yet little about the ambivalent role of PowerPoint in various settings that go beyond the classical use for facilitating presentations.

3.2.3 PowerPoint's Features

If we want to clarify PowerPoint’s role in digital innovation practices, it is first necessary to characterize PowerPoint as technology. Thus, the following section defines

the bundle of material properties of PowerPoint. We group these into presentation features, editing features, and organizational features.

3.2.3.1 Presentation Features

Presentability: PowerPoint slides can be projected onto a wall. Many modern meeting rooms or lecture halls are equipped with an according projector. A dark, sleepy environment is necessary to visibly display the slides (Kernbach et al., 2015). Only the presenting person can control the slideshow using the computer keyboard or a remote presenter. The slides cannot be edited in the presentation mode, but the separate computer screen can show a presenter view that displays editable presentation notes.

Animatability: Various slide transition effects (e.g. fade in/out, slide in/out) and object animations (e.g. fly in/out, rotate, path animation) can mark transitions in the slideshow during the presentation mode. (Kernbach et al., 2015)

3.2.3.2 Editing Features

Malleability: Although originally intended broadly as a software for editing and presenting slides, PowerPoint itself does not prescribe narrowly defined use practices – it is a malleable end-user software (cf. *blinded for review*). The standard edit mode is generally flexible and a PowerPoint slide may contain a variety of objects, including free text, lists, comments, presentation notes, formulas, links, graphics, images, shapes, tables, diagrams, audio, and video. The user is only constrained by the limited available space per slide and the limited (though extensive) set of templates for editing objects. A further constraining quality, which has far-reaching consequences for digital innovation practices, is the lacking semantic representability of objects in PowerPoint. For instance, boxes and arrows have no semantic representation as entity-relationships, but only as graphical objects.

Modularity: It is possible to combine and recombine the loosely coupled components of a PowerPoint slideset (Yoo et al., 2012). Objects in PowerPoint, as well as slides containing them, can be transferred easily to another PowerPoint slideset, to another place in the same slideset, or to a variety of other files in the widely used Microsoft Office format (e.g. Word, Excel, or OneNote files). This only requires a simple copy-paste operation.

Sequentiality: The PowerPoint slideset is an ordered, potentially unlimited, serial sequence of slides. One may jump to the n-th slide in the standard editing mode relatively quickly, but it is only possible to move back or forth one slide after another during the presentation mode (Tufte, 2003).

3.2.3.3 Organizational Features

Integrability: PowerPoint is highly embedded into the material infrastructure of everyday work practices (Schoeneborn, 2013). The software is integrated into the widespread Office suite, runs on multiple operating systems (e.g. Windows and OSX), and a variety of third party tools are able to open and edit PowerPoint files (e.g. Keynote, LibreOffice, or Google Docs). In addition, a variety of web applications are able to display PowerPoint slidesets (e.g. Slideshare, Atlassian confluence, Sharepoint).

Digitality: While a PowerPoint slideset relies on a certain physical infrastructure for its execution (e.g. keyboard, mouse, computer, screen, projector, wall, remote presenter), PowerPoint itself is a purely digital artifact and, thus, inherits some distinctive characteristics from digital technologies (cf. Yoo et al., 2010). For instance, one can make unlimited perfect copies of PowerPoint slidesets, easily share them via digital media channels (e.g. e-mail, file systems, web applications, social media), and store them for an unlimited period of time without expiration (Yoo, 2010). Search algorithms can index and find the text content of PowerPoint files.

3.2.4 Paradoxes

Given the many contradictory tensions we present in this study, we adopt a paradox lens to illustrate and make sense of the ambivalent practices afforded by PowerPoint. Smith and Lewis (2011, p. 382) define paradox as "*contradictory yet interrelated elements that exist simultaneously and persist over time*". This definition emphasizes two properties of paradox: 1) the existence of tensions between two underlying propositions A and B that seem plausible individually but impossible when juxtaposed and 2) the necessity of responding with coping strategies that embrace these tensions simultaneously (Lewis, 2000). Poole and Van de Ven (1989, p. 565) advocate four such coping strategies: 1) acceptance, i.e. keeping A and B separate and their contrasts appreciated, 2) spatial separation, i.e. situating A and B at two different levels of analysis, 3) temporal separation, i.e. switching between A and B in the same location at different points in

time, and 4) synthesis, i.e. finding a new perspective that eliminates the opposition between A and B (cf. Smith and Lewis, 2011, p. 385).

In recent years, paradoxes of our increasingly complex social world attract considerable attention in the social sciences, particularly in management studies and organization studies (Smith and Lewis, 2011). Unlike logical paradoxes, which have a long tradition in philosophy, social scientific paradoxes oppose terms that are often somewhat vague, and tensions between incompatible propositions in the social world must be considered, rather than dealing with logical contradictions (Poole and Van de Ven, 1989). Instead of striving for harmony and consistency, looking for theoretical tensions and using them in a creative way creates an opportunity to develop more encompassing theories that capitalize on the duality of paradoxical tensions (Eisenhardt, 2000; Poole and Van de Ven, 1989). In IS research, paradoxes can be used as rhetorical device to create appealing tensions that expose novel insights of the irony and dillema that flexible digital technologies embody (Dubé and Robey, 2009; Gregory et al., 2015; Robey and Boudreau, 1999).

Given our aim to examine a technology (here: PowerPoint) and a practice (here: digital innovation) in parallel, we furthermore take an affordance perspective to explore the materiality of PowerPoint in relation to digital innovation practices. Perceptual psychologist James J. Gibson (1977) introduced the theory of affordances to study action possibilities for animals (including humans) in relation to the properties of a given environment. In IS research, the concept of affordances has recently been adopted extensively to examine the possibilities for goal-oriented action afforded to specified user groups by information systems in the context of practices (Faraj and Azad, 2012; Leonardi, 2011; Markus and Silver, 2008). The key insight offered by the affordance concept is that material properties existent in technological objects are contingent on, but not constitutive of, users' perception, interpretation, and appropriation in a given practice (Markus and Silver, 2008; Zheng and Yu, 2014). This leads us to the insight that affordances depend on the goal of the practice in which they are enacted, thus emphasizing the importance of understanding "*how the specific action unfolds in that unique moment and situation, whom and what it enrolls, and how it affects the world*" (Faraj and Azad, 2012, p. 255).

3.3 Research Method

Since we expected to discover novel insights from examining PowerPoint's role in digital innovation practices, we used a grounded theory approach to theorize from an interpretive case study (Walsham, 1995, 2006) at two European software companies. Following the principle of emergence, we inducted concepts through the systematic generation and conceptualization of data (Glaser and Strauss, 1967). We used an iterative approach to data collection and analysis until a coherent picture emerged, moving back and forth between theories and the different interpretations of the case study material we obtained from social constructions such as language, shared meaning, documents, tools, and other artifacts (Klein and Myers, 1999). The specific research question of this paper emerged according to our deepening understanding and conceptualization of the data. We purposefully accepted some vagueness in the beginning of the study, giving close care to not forcing existing theory into the subjects and the emerging claims that resulted from our interview analyses (Urquhart, 2013).

3.3.1 Research Relationship with the Case Companies

We entered the research sites with little previous understanding of digital innovation practices. Since the related literature suggests that digital innovation practices can be observed where people develop novel products, processes, and business models that are embodied in or enabled by IT (Fichman et al., 2014; Yoo et al., 2010), we selected the following two companies, where we expected high involvement of digital artifacts in the development and outcome of the innovation (names are anonymous for review).

Banking and IT Solutions (BITS): For more than 20 years, the traditional business model of this company has been the development, distribution, and operation of its proprietary core banking system. After the executive board became increasingly concerned that the lifecycle of this product might have peaked, BITS took various extensive measures to develop new products and services in the areas of mobile banking, outsourcing, financial services, and consulting. Our style of involvement with BITS was that of a closely involved researcher having in-depth access to data, issues, and people, who viewed the researcher as one of 'them', trying to make a valid contribution to the field site (Walsham, 2006).

Custom Software Engineering (CustomSoft): For almost 20 years, the core business of CustomSoft has traditionally been the development of and consultancy for custom business software in segments including transport, health, space agencies, public administration, banks, and insurances. In order to reduce the financial risk stemming from the company's high dependence on client orders, CustomSoft recently initiated efforts to rethink its business model from a project engineering to a product company, like BITS. The style of involvement with CustomSoft was that of an outside observer who was not seen as having a direct personal stake in various interpretations at outcomes, with personnel being relatively frank in expressing their views (Walsham, 2006).

In both companies, work is largely structured around generating novel solutions to novel problems. Through these complementary approaches, we had the unique opportunity to study digital innovation practices in depth. Much to our surprise, we found that the seemingly mundane, general-purpose tool PowerPoint was highly prevalent innovation practices at BITS, and we consequently felt an urge to better understand and explain this phenomenon.

3.3.2 Data Collection

In collecting our data, we followed the principle of theoretical sampling in that we purposefully selected, collected, and analyzed the next data slices (e.g. views from particular participants, secondary PowerPoint slides, or field observations) according to what was necessary to construct the emerging theory (Glaser, 1978). The first author was the primary responsible for collecting all data from the case companies. Table 1 provides an overview of data collection and analysis techniques, and the following sections provide further explanations.

Table 3-1 : Overview of Data Collection and Analysis

Data Source	Interviews	Artifacts	Participant Observation
Total Amount	95 Interviews - BITS: 62 participants - CustomSoft: 33 participants Word Count: 612,401 Length - total=5677 minutes - average=59.76 minutes - minimum=19 minutes - maximum=104minutes	122 PowerPoint slide decks - BITS: 116 slide decks - CustomSoft: 6 slide decks	213 days =1810.5 hours - BITS: 196 days - CustomSoft: 18 days Passive: workplace observations, meeting attendance, and informal contacts Active: talks, workshops, steering meetings, collaborations
Data Analysis Technique	Coding (Corbin and Strauss 1990)	Genre Analysis (Yates and Orlikowski 2007)	Focus Groups (Weber 1990)

This author conducted 95 semi-structured interviews ranging from 19 to 104 minutes (average 60 minutes) with experts involved in recent innovation projects at BITS and CustomSoft. By interviewing a wide range of participants with differing roles and from different units we were able to seek out and document multiple interpretations of the actions under study (Klein and Myers, 1999, p. 77). The author used a semi-structured interview guide to ensure topical focus and consistency while also allowing respondents to freely express their own views. We recorded and transcribed all but two interviews to capture a full description of what was said and facilitate later in-depth analysis. Through these interviews, it was possible for us to step back and access the interpretations of the fellow participants in more detail (Walsham, 1995). We wrote up detailed interview notes within a day.

Following the idea of triangulation (Silverman, 2006, p. 291), we relied on multiple sources of evidence, compiling multiple interpretations obtained from interviews, observations, field notes, and documentary material into a coherent picture (Klein and Myers, 1999). For instance, we collected and analyzed 122 PowerPoint slide decks that participants sent us. In addition, the author conducted a series of participant observations at formal gatherings (meetings, workshops, presentations and fairs) and informal gatherings (lunches, impromptu meetings) in the context of the innovation

projects, spending in total 211 full days at the research sites between 2013 and 2015. Where possible, photographs and field reports complemented the observations.

3.3.3 Case Data Analysis and Interpretation

In analyzing the case data we followed the principle of induction, interaction, and multiple iterations, generating shared meaning from the collected data through qualitative data analyses, interactions between authors, and interactions between authors and informants from practice (Walsham, 1995). At first, we met in weekly focus groups to maintain a critical distance of the involved researcher with the views of people in the case companies, moving back and forth between data and theories, interrogating field material to check whether the data supported emerging claims and, conversely, whether theories helped us making sense of the empirics (Walsham, 2006).

We then cross checked the transcriptions among the research team and imported them in MAXQDA to initiate a process of open, axial, and selective coding (Corbin and Strauss, 1990) leading finally into theoretical coding (Glaser, 1978; Urquhart, 2013). We started with open coding, i.e. "*coding the data in every way possible*" (Glaser, 1978, p. 56) and generating many tentative categories from the observed instances. In our case, we generated over 200 initial codes and tentative categories (e.g. technical properties, human practices, innovation process stages). Next, we engaged in axial coding, i.e. making connections between sub-categories to construct a more comprehensive scheme (Corbin and Strauss, 1990). In our case, we relied on genre analysis (Yates and Orlikowski, 2007) to classify the collected PowerPoint artifacts in the context of their use practices (e.g. idea generation, coalition building, experimentation). In a third phase, we proceeded with selective coding, i.e. focusing the subsequent analysis on the "*concept-indicator model, which directs the conceptual coding of a set of empirical indicators*" (Glaser, 1978, p. 62) by unifying categories and relating them to a core category. In our case, based on constant comparison between our emergent claims and existing theory, we identified the key research gap on PowerPoint paradoxes in digital innovation practices. Finally, we engaged in theoretical coding and conceptualized how the codes and core concept relate to each other "*to be integrated into a theory*" (Glaser, 1978, p. 72). Table 1 illustrates the final version of the codebook with the classification of codes into

categories and sub-categories. Figure 1 (next page) and the following sections describe the relationship between the codes in detail.

Table 3-2 : Final Version of the Codebook

Code Category	PowerPoint Feature	PowerPoint Practice	PowerPoint Paradox (Core Category)
Code Attributes	**Editing Feature** • Malleability • Sequentiality • Modularity **Presentation Feature** • Presentability • Animatability **Organization Feature** • Digitality • Integrability	**Personal Practice** • Simplification • Overloading • Freely Expressing Oneself **Interpersonal Practice** • Embracing Flexible Interpretations • Bargaining • Distancing	**Freedom/Captivity** **Clarity/Ambiguity** **Scarcity/Abundance**
Sources	Related Literature (cf. section 2)	Interview Statements (cf. sections 3.2 and 4)	Previous codes (cf. section 3.3)

In addition, we provided the case companies with continuous feedback and opportunities to reflect on their own practice (Walsham, 2006). Having key informants from the companies review our in total four interim study reports enabled them to reflect on our findings and report any discrepancies with their interpretations. We discussed the emerging findings of the study in intensive workshops and presented them at company-internal talks to help practitioners reflect on and improve their own practices.

When we realized that we entered a stage of theoretical saturation, as new data slices did not add substantially to our emerging theory, we initiated the phase of theoretical integration and wrote up the results (Glaser, 1978). In writing up this paper, we oriented ourselves toward the criteria for convincing ethnographic texts advocated by Golden-Biddle and Locke (1993), namely authenticity, plausibility, and criticality.

3.4 Results: PowerPoint Paradoxes in Digital Innovation Practices

So far, we argued from previous literature that PowerPoint is a widely used tool with distinct characteristics that are worth examining in an innovation context. We also introduced our in-depth case study of PowerPoint use in digital innovation practices at

BITS and CustomSoft. In this section, we develop three PowerPoint paradoxes from the insights that we obtained in our case study. The three paradoxes are: 1) *Freedom* and *Captivity*, 2) *Clarity* and *Ambiguity*, and 3) *Scarcity* and *Abundance*. Table 3 provides an overview of the three paradoxes and the following sections provide further details. We frame each paradox with a short summary before we dialectically examine it, grounding both its thesis and antithesis with empirically observed practices at BITS and CustomSoft. In the synthesis that follows, we identify ways of coping with these paradoxes that are grounded in literature, interview statements, and our own reflection on the case study.

Table 3-3 : Overview of PowerPoint Paradoxes in Digital Innovation Practices

Paradox	**Thesis**	**Antithesis**	**Synthesis**
Freedom/Captivity	PowerPoint's *malleability* affords expressing creative ideas freely.	The PowerPoint *template*, the *lack of semantic representability*, and *social orthodoxies* around PowerPoint hold people captive and inhibit creative interaction.	PowerPoint affords individual creativity in early innovation process phases and constrains interpersonal creativity later.
Clarity/Ambiguity	PowerPoint's *modularity* and *sequentiality* afford clarification by structuring thoughts, simplifying complex issues, and breaking down large topic blocks into smaller ones.	PowerPoint affords complication through *semantically ambiguous* and *interpretatively flexible* slides.	PowerPoint affords individual clarification during the production of slides, but also affords interpersonal complication during the consumption of slides.
Scarcity/Abundance	PowerPoint's *limited functionality* and *limited space per slide* afford information scarcity by constraining the amount of displayable information.	PowerPoint's *digitality*, *integrability*, and *sequentiality* afford information abundance through potentially unlimited (re)production, dissemination, and storage of slides.	PowerPoint affords scarcity of high-quality information on the slide level and, thereby, affords abundance of low-quality information on the document level.

3.4.1 PowerPoint Paradox 1 - Freedom/Captivity

From studying digital innovation practices at BITS and CustomSoft, we learned that PowerPoint has both freeing and captivating qualities that afford and constrain people's freedom of creative expression. As a malleable, ready-to-hand, and easy-to-use slide editing software with low entry barriers, innovators use PowerPoint flexibly to adapt to the various weakly structured practices in an innovation process. However, as a widespread, proprietary, and captivating slide presentation software with high exit barriers, PowerPoint is deeply entangled into organizational infrastructures, practices, and expectations, which can constrain creative interaction. We term this the Freedom/Captivity Paradox, and provide an empirically grounded dialectical appraisal in the following.

Thesis T1 ("Freedom Thesis"): PowerPoint's malleability affords expressing creative ideas freely.

The Freedom Thesis is rooted in PowerPoint's malleability. In PowerPoint, people can create visual representations of early ideas freely without having to conform to narrowly defined visual semantics. Editing slides can be done quickly and easily, and without much prior knowledge of PowerPoint. Through their digitality, PowerPoint slides afford unifying, combining, and merging a variety of different kinds of content in one document. Our data shows that this malleability (and the resulting homogeneization of content) afford a degree of free creative expression that many participants appreciate in an innovation context. Its wide-spread use and readiness-to-hand leads people to use PowerPoint in a large variety of innovation practices.

For instance, we observed that innovators freely express themselves using PowerPoint for brainstorming and idea generation. From the very beginning of an innovation process, where a creative spark leaps across the mind, PowerPoint accompanies people in freely expressing ideas, as exemplified here:

> *"Every now and then, I open PowerPoint and simply draw for myself. I illustrate my creative process in there, and when I get the impression that something interesting comes out, I present it directly and discuss it further. That can for example be an architectural*

model or a process model when I want to improve a process, it can also be a mockup when it's about usability." [Quotation from interview participant 16, further i16, Product Manager BITS]

Although PowerPoint is not the only brainstorming tool used at BITS and CustomSoft, we could not find a single innovation project of which PowerPoint was not part already from an early phase. Even when the first ideas had been generated outside of PowerPoint, there was at least one intermediate step at some point in which PowerPoint was involved to encapsulate the innovative vision, as exemplified here: "*I often work with mind maps, or in workshops with lists on whiteboards, to brainstorm. I then try to capture the ideas in PowerPoint.*" [i7, Software Architect, BITS]. Such observations were consistent throughout all different organizational roles, teams, departments, and projects. The phenomenon of PowerPoint use in innovation practices was so striking that we felt urged to better understand and explain why and how all kinds of innovators would make such extensive use of PowerPoint in such different contexts, although we assumed there are other, more sophisticated tools available.

Many participants describe PowerPoint as some sort of digital white canvas where they feel relatively unrestricted in what type of content to create and how to create it, as exemplified here: "*PowerPoint is an incredibly good tool to do things quickly and easily.*" [i73, Product Manager, CustomSoft]. As opposed to purpose-specific tools, which often prescribe more narrow semantics, PowerPoint allows expressing ideas more freely, which seems to better fit the vague character of innovation practices. For many participants, PowerPoint is indispensable in such practices as conceptualizing, bargaining, and exchanging ideas, as exemplified here: "*PowerPoint is the main medium for various artifacts (...). In my role, I need to interact extensively, and PowerPoint is simply good for interaction."* [i33, Program Manager, BITS].

This malleability is not confined to using PowerPoint in the conventional way, namely as presentation tool. Much to our surprise, innovators at BITS and CustomSoft use PowerPoint in ways that go far beyond its originally intended purpose of editing and presenting slides, such as software modeling and prototyping. Given that we and colleagues at our university institution put considerable effort in teaching our computer science students the merits and skills of creating semantically clear software diagrams and prototypes with adequate tools, we were eager to find out why many of our

graduates seemingly refuse to apply that knowledge in practice. One participant explains the advantages of modeling in PowerPoint rather than UML-based tools such as Agilian by Visual Paradigm and Visio by Microsoft as follows:

> "*(Everybody has) Agilian. Nobody uses it. (...) It is the learning curve of using it. In PowerPoint, you just go in and you just draw your shapes. That is fine and you move on. (...) Whereas in Agilian, you have UML. That is one example you have to learn. It is the time that you need to invest to do a use case diagram properly. (...) That is why we do not use Agilian. (...) I know Visio is used by some other people, not everyone has that. I do not have it. Again, this is used for drawing diagrams that you could probably do (in) PowerPoint.*" [i50, Middle Manager, BITS].

This use of PowerPoint is not limited to only less experienced practitioners who did not learn how to do architectural software diagrams "right". Modeling in PowerPoint seems institutionally anchored for the following rationale: If it is easier for a larger number of people to model in PowerPoint, and the produced diagrams serve their intended purpose, then why bother spending additional effort (and money) on creating more precise diagrams with specialized, costly, and cumbersome tools? The commercial software products of BITS, for instance, are often documented in numerous PowerPoint slides comprising software diagrams (e.g. use case-, activity-, sequence-, and entity-relationship diagrams) that are essentially all done in PowerPoint. There is even an official internal PowerPoint template that contains over a hundred predefined shapes for putting together software diagrams (e.g. objects, relations, processes, tables, messages, etc.). All this even though BITS puts strong emphasis in selective recruiting of university graduates with a strong background in IT. But, its business model requires BITS to design its software in close collaboration with less technical organizations, namely banks. Here, formal modeling languages like UML would be of little value, as two senior software architects explain: "*The UML standard is not adhered to at all, because nobody appreciates it anyway.* (Our drawings) *are simply boxes and arrows, and the discussion around them is important. The drawing is just a reminder of how it was thought.*" [i14, Technical Lead]. "*At the end of the day, whether you model with UML or PowerPoint does not matter at all.*" [i12, Technical Lead]. Moreover, particularly in an innovation context, where the outcome is not yet clearly defined, many participants find it easier and faster

to create a rough high level design in PowerPoint, rather than having a complete design in mind and formally specifying it in UML.

In a nutshell, the Freedom Thesis states that PowerPoint flexibly adapts to many weakly structured innovation practices, giving innovators extensive freedom of creative expression.

Antithesis AT1 ("Captivity Thesis"): The PowerPoint template, the lack of semantic representability, and social orthodoxies around PowerPoint hold people captive and inhibit creative interaction.

Whereas some participants appreciate that the standard PowerPoint templates afford the quick generation of a relatively professional-looking slideshow, others criticize that these templates strongly limit the possibility to design more creative content according to individual tastes. In the first place, innovators in our cases feel constrained by the limited available space per slide and the limited set of shapes to choose from. In addition, PowerPoint affords abbreviating sentences in a bullet list style, as exemplified here: *"We had a set of PowerPoint templates that we had to use. But me being the slightly rebellious technical writer, (...) I wanted to present something in a certain way, but I was being restricted because I had to conform to the template."* [i46, Technical Writer, BITS].

Moreover, PowerPoint's malleability comes at the cost of limited semantic representability, which strongly limits the possibility of a structured import or export. For instance, the innovators in our case study use PowerPoint to mock software diagrams or prototypes, but not to export these objects such that they could continue working on them in a dedicated software, since it is not possible to import such data from other tools without losing all semantics. Hence, the flexibility of PowerPoint backfires when people want to further collaborate, as exemplified here: *"Just try once to draw a sequence diagram in PowerPoint and you give up. At best, you will get an image (...), but one cannot continue working on it."* [i30, Software Engineer, BITS]. Without the possibility for further computer-aided development on the objects created in PowerPoint, it is impossible to perform important software engineering tasks such as code generation, linking objects semantically across tools or even within the same tool.

The seemingly so easily created PowerPoint objects become throwaway artifacts with limited reusability, as exemplified here:

"We always have to start from square one again and create the slides anew from scratch. (...) We actually should agree on a tool, such that everybody uses the same. (...) One guy prefers Visio, the other Agilian, and what not. If we would only prescribe which tool to use in this company, that would already create value. But everybody has a different opinion on that and if you would introduce something, that would already be a change project." [i7, Software Architect, BITS].

Social orthodoxies around PowerPoint are a further constraint to creativity. After many years of deep anchorage in organizational communication, PowerPoint is so deeply entangled in today's everyday office work practices and people's consciousness at BITS and CustomSoft, that a PowerPoint presentation is the expected format in many situations, as exemplified here:

"We are so used to having a title and then five bullet points. (...) There is an accepted type of slides that is always expected, and if anything is different from that it is almost as if people think, 'Oh, that is not right. What is this?'" [i46, Technical Writer, BITS].

Social orthodoxies at BITS and CustomSoft are not only confined to the expectation *that* PowerPoint should be used in many settings, but also include expectations *how* PowerPoint should be used. In an innovation process, it is often necessary to persuade different audiences of one's intended goals in order to pass through various quality gates. Here, PowerPoint remains a preferred choice to visualize the essence of an idea. Given that innovation practices at BITS and CustomSoft at some point require the persuasion of a paying customer or other internal or external idea sponsors, a commonly expected setting for a PowerPoint presentation is the sales pitch. We observed that presenters of PowerPoint slides often develop a selling attitude, often coupled with a tendency to commercialize and exaggerate. For instance, both companies organize similar recurring events where employees can give an elevator pitch of their idea in a couple of minutes to acquire funding or other support by the company. The main medium of these sales pitches is, of course, the PowerPoint presentation:

"PowerPoint works well if you need money. Then, you need condensed slides. I recently learned that you already have to illustrate everything in an abstract on the first slide. Even in

PowerPoint you need a management summary, because often times you don't even pass the first slide. [i6, Technical Lead, BITS]

At times, this strong expectation to use PowerPoint in a certain way resembles a social coercion. Although many innovators at BITS and CustomSoft dislike PowerPoint's creativity-inhibiting limitations, most of them would still not dare to enter an important meeting without preparing a PowerPoint presentation with utmost care if they expect a certain outcome: *"I have learned that I am only successful when I adequately illustrate what I want to achieve.* [...] *So when I need a decision, I create a PowerPoint, because that is just how it is done here."* [i8, Middle Manager, BITS]. Many participants would like to see more willingness to informally discuss unfinished ideas among their colleagues, but PowerPoint creates barriers: "*The hurdle to present something is very high here, because everyone always expects high class presentations. It rarely happens that somebody says 'come and tell me what you think in a 15-minute coffee break.'*" [i6, Technical Lead, BITS].

Only very few participants stated that they outright reject using PowerPoint for discussing ideas. For instance, because of the distance it develops between creator and content, using PowerPoint can lead to less emotional engagement than drawing with a pencil, as exemplified here:

"I mean, the PowerPoint would be so sterile. (...) I do not think it allows me to grow because (...) the emotional substance is just not there. (...) What I like about the drawing board is (that) I can get some immediate feedback, and I can immediately improve. I can erase something; I can come up with something else." [i63, Software Engineer, CustomSoft]

PowerPoint further puts the presenter in a dominating position over the audience, because only one person can control the presentation and edit the document at any given moment. Thus, presenters are tempted to develop overly fixed, closed, and previously defined opinions, because the presentation cannot easily be altered in response to the dynamics of the discussion.

"The PowerPoint though, that's (…) just the obvious thing to show us a digest or the bullet point items of an idea. It's more of a one-way mechanism though, there's no real collaborative element." [i46, Technical Writer, BITS].

In addition, the presenter usually stands close to the projected slides, and in moderate distance to the audience that sits in the necessarily darkened room. This creates a narcotic, distanced atmosphere that hinders creative interaction and discussion.

Synthesis S1: PowerPoint affords individual creativity in early innovation process phases and constrains interpersonal creativity later.

In accordance with Smith and Lewis' (2011) definition of paradox, we have now juxtaposed two contradictory yet interrelated elements that exist simultaneously and persist over time, namely PowerPoint's enabling and inhibiting effects on creativity. As noted in the literature review, Poole and Van de Ven (1989) propose coping strategies that include acceptance and resolution. In the case of the Freedom/Captivity Paradox, we observed that innovators apply a coping strategy that involves temporal and spatial separation.

First of all, it is important to note that both PowerPoint's freedom and the captivity have beneficial and detrimental effects on innovation practices. Freedom of creative expression is a basic prerequisite for innovativeness, particularly in so-called divergent phases of idea generation, where blue sky thinking and broadening up the possible solution space is important. Here, PowerPoint initially appears as flexible instrument for the creative individual. However, unrestricted freedom is not always conducive to the innovation process all the time, because at some point the amount of generated ideas may exceed the available resources for developing them. At this point it seems desirable to narrow down the possible solution space again and start a convergent phase, in which decisions about ways to continue are important (cf. Dennis et al., 2008). Here, PowerPoint shows its presence as mediating communication device between different stakeholders, and PowerPoint's constraining qualities can indeed help to focus on the essence of an idea. However, when using PowerPoint for this purpose, users should be aware of the inherent danger of distancing oneself too much from the idea and the intended audience. Instead of structuring discussions along PowerPoint slides, the slides should be seen as an anchor to which people can return when a visual representation of the disputed issues is necessary.

Hence, a temporal separation of the Freedom/Captivity paradox reveals that people tend to experience the freeing and captivating qualities of PowerPoint at different points in time. Namely, in early, divergent phases of the innovation process that require idea generation, PowerPoint affords expressing creative ideas freely through its

malleability. But this freedom is never unrestricted. As Yates and Orlikowski (2007) point out, affordance and constraint cannot be considered as separate aspects, but rather as two sides of the same coin. In the same way as a freeway can give a car driver the impression of a free voyage while simultaneously forcing the driver to stay on the paved road, PowerPoint's freeing and captivating qualities cannot be separated. Especially in later, convergent phases of the innovation process that require idea selection and elaboration, PowerPoint shows its constraints. Without the possibility of semantic representation, the objects created in PowerPoint cannot be reused outside of PowerPoint. Moreover, social orthodoxies force people to use PowerPoint in certain settings and in certain ways.

In turn, a spatial separation of the Freedom/Captivity paradox reveals that people tend to experience more of PowerPoint's freeing qualities in individual settings (e.g. while editing slides for oneself), whereas all involved stakeholders tend to experience more of PowerPoint's captivating qualities in interpersonal settings (e.g. while presenting slides or collaboratively editing them). In our case study, people escaped from this captivity by complementing the strengths of PowerPoint with the strengths of other tools, such as using whiteboards in workshops, or dedicated software modeling or prototyping tools to professionalize the objects created in PowerPoint. We found that this exchange could be strengthened by providing better possibilities for structured import and export.

3.4.2 PowerPoint Paradox 2 - Clarity/Ambiguity

It further became evident in our case study that PowerPoint plays a paradoxical role in people's decision making practices at BITS and CustomSoft. In some instances, we observed that PowerPoint helps people to clarify complex issues that require making a decision on which way to proceed in the innovation process. For instance, given the limited available space per slide and the strong affordance to abbreviate, participants used PowerPoint extensively to structure and simplify ideas, which may have both positive and negative outcomes on innovation decisions. In other cases, we found that using PowerPoint can lead people to dilute content, leading to complications and ambiguities that may both enable and inhibit innovation decisions. For instance, given the interpretively flexible nature of semantically ambiguous PowerPoint slides,

participants were often confronted with diverging (mis-)interpretations, which they sometimes embraced purposefully to stimulate discussion, often however without the desired outcome. We term this the Clarity/Ambiguity Paradox, which we examine in the following.

Thesis T2 ("Clarity Thesis"): PowerPoint's modularity and sequentiality afford clarification by structuring thoughts, simplifying complex issues, and breaking down large topic blocks into smaller ones.

In the previous section on the Freedom/Captivity paradox, we touched upon the finding that digital innovation practices at BITS and CustomSoft usually involve alternating sequences of individual and interpersonal practices. Recalling this aspect is a starting point to conceptualize the Scarcity/Abundance paradox.

From studying BITS and CustomSoft, we learned that two conditions are essential to facilitate digital innovation. Firstly, it usually takes an ingenious individual, or a small group of ingenious individuals, as a driving force behind any innovation project. These individuals need facilitating conditions to continuously elaborate the idea, make sense of it, and peel out its essential core. Secondly, coalition building is an integral part of the innovation process, requiring continuous persuasion, collaboration, and alignment with relevant stakeholders.

Here, we observed that people use PowerPoint as a guide to simplify complex content, structure thoughts, and break down large topic blocks. These clarifying qualities of PowerPoint are in part supported by its captivating qualities (cf. AT1). For instance, recall that many participants described how PowerPoint's limited template strongly affords abbreviating sentences and creating high-level visual illustrations that fit on the limited available space of the sequential slides. While some innovators at BITS and CustomSoft feel inhibited by this, others exploit these characteristics as an aid to focus on the essential aspects of an idea, as exemplified here:

"I typically begin with mind maps. In general, you start from a problem, and there it already begins: How do I even formulate what I actually mean? (...) Here, mind maps are quite good to structure the thoughts. (...) In the next step I then often work with charts or diagrams, where I try to visualize certain things to the customer. (Then,) I move toward a presentation

relatively quickly because you need to get to the point there even more." [i25, Middle Manager, BITS].

We often observed that innovators at BITS and CustomSoft profit in two ways from using PowerPoint. Firstly, using PowerPoint to create high-level visual illustrations of ideas advances their own individual sense making process. Secondly, presenting these PowerPoint slides to others enables alignment with various stakeholders. The combination of both contributes to the maturing of the idea, as exemplified here:

"When it is about bigger things I typically create a PowerPoint that simply sketches and visualizes the underlying idea. This PowerPoint has then of course the advantage that you can replicate it, send it around, and look at it with different people. This way, you really have something in your hands. (...) And because you really have something in your hands, you can let other people's feedback flow (in) and you can really let your idea grow visually, so to speak. (...) PowerPoint is always the easiest and best way to replicate such stuff." [i34, Project Manager, BITS].

This practice of letting an idea "*grow visually*" in PowerPoint is salient in our case study, and it is strongly afforded by PowerPoint's sequentiality and modularity. We often observed that many innovators at BITS and CustomSoft exploit PowerPoint's sequentiality to demonstrate how various components build on one another by gradually constructing complex structures slide by slide:

"Once there is this certain degree of structuration, PowerPoint is a good medium, because one can create graphics relatively fast and simple. […] The PowerPoint slides from (a recent project) would be a positive example. One of the central elements was the object model, which we expanded extensively. […] We could visualize the object model quite well, and construct additions from one slide to another, whereby we started with the simplest version and built upon it step by step." [i7, Technical Lead, BITS]

We observed this technique particularly often in innovation workshops that participants held with customers or project partners, where the innovators usually help the relevant stakeholders to get a better understanding of the current and future situation by "*showing one process as it is today and then one process with or after the innovation."* [i6, Technical Lead, BITS]. It is also possible to use this technique to create visual previews of envisaged software products: „*Show a few screenshots in PowerPoint, indicate with an arrow to what will go where, switch to a live demo and then go back to the*

presentation." [i23, External Partner]. At times, this can take quite unexpected forms, as some participants develop rather original variations of this technique. Not only do people use PowerPoint as a container for screenshots of a prototype. We observed how some participants create mocked prototypes *in* PowerPoint! For instance, one participant describes his PowerPoint prototyping as follows:

"I can take screenshots of the existing application, and take wireframes where I do not have something, yet. I file both into PowerPoint and then walk the customer through it step by step. […] This way, the customers get an impression of how the final system would look like, which is very important in that design phase, because they can tell directly when they do not need something. So when you communicate over these instruments in that phase, you benefit in two ways: You reflect upon your ideas and strike things through that lead to a bad usability. In addition, you get customer feedback immediately, and that is good quality feedback because they see directly where they're going to." [i11, Technical Lead, BITS]

PowerPoint's modularity further affords consolidating different views and helps people to reach a common understanding. For instance, various visual illustrations can easily be copy-pasted and modified, such that one can further elaborate the overall picture, as exemplified here:

"(In our recent project), we first said: 'okay, everybody who holds a stake in there, everybody should draw (their viewpoint) in a PowerPoint'. Then I took those PowerPoints, pasted all the variations one after another, and then I finally drew my consolidated picture out of this thing. And then I revised this consolidated picture together with the other people. We then really sat together and drew this PowerPoint together." [i34, Project Manager, BITS].

Peeling out the essential aspects of an idea is also important for continuously securing stakeholder commitment. Once a clear message has been shaped, it can also be reused and shared with others. Here, we observed that certain PowerPoint slides are often shown again and again in various settings to remind people of the target picture. For instance, one participant compliments a colleague, because:

"*His slides are always of that kind that the whole (BITS) gets it. (…) It is always PowerPoint, but what distinguishes his slides from others is pragmatism. [...] It is the kind of (presentation) that can be presented by other people, too, and the message is still loud and clear."* [i8, Middle Manager, BITS]

Sometimes, however, this apparent clarity can also be deceiving. Given their frequent exposure to polished PowerPoint Slides, we observed that viewers tend to have the (often false) impression that all the important information is present on the slides, often ignoring the existence of valuable knowledge that goes beyond the slide. Thus, it is very easy to overestimate the actual maturity of an idea presented in PowerPoint and to underestimate the necessary completion effort. This bias is exacerbated by the circumstance that presenters tend to develop a tendency to oversell and exaggerate. Not seldom have we observed that innovators were afterwards unhappy with overly positive feedback for their overly clear PowerPoint presentation, because they would have desired more critical feedback:

> *"At the next architecture meeting I simply showed the presentation for (my idea). Afterwards, they just said 'okay, we do it like that' (...) and I was really a bit excited that it went down so easily. (...) They said 'you just do it now. We do the architecture exactly as in the presentation' and I just told them 'well, great that you have so much trust in me, but do you really know what that means?' and I immediately signaled that their envisioned project duration was surely not realistic."* [i31, Software Architect, BITS]

In sum, it remains to be emphasized that PowerPoint plays an important role in the process of clarification, which is essential for decision-making in an innovation process.

Antithesis AT2 ("Ambiguity Thesis"): PowerPoint affords complication through semantically ambiguous and interpretatively flexible slides.

We have also observed many instances where using PowerPoint dilutes content, fosters ambiguities, and complicates things. This is particularly problematic in the often-observed case when a PowerPoint presentation serves as main (sometimes even as only) project documentation. Even if a certain inner group of involved people may have managed to obtain a common understanding through PowerPoint, there is no guarantee that the produced PowerPoint slides convey the message unambiguously to all stakeholders. Hence, people at BITS and CustomSoft often complained about ambiguous, decontextualized, or simply incomprehensible PowerPoint slides that are sent around via mail or archived in intranet platforms, as exemplified here:

"A presentation is not equal to a document, because in a presentation you are on a higher level of abstraction than in a document. Because, if you only write bullet points instead of whole sentences, you are far from being as precise as you actually should be to create something that later functions as independent communication device. From a document, I generally expect that I can make sense of it without having to come back to the author. But a slide set is usually coupled to the presentation. A slide set sent by mail is insufficient. That was unfortunately often the case, that we just received last year's tech talk slides and should do something with them." [i28, External Partner, BITS]

Not only is it problematic to overuse bullet point items instead of text, but also does the lack of semantic representability make it very difficult to draw unambiguous and semantically clear diagrams. Hence, in stark contrast to the abovementioned proponents of modeling in PowerPoint, there are opponents with strong opinions on this topic:

"I am not one of those people who want to illustrate everything with diagrams. I think that goals, for instance, must be written down in natural language, because it forces the person to become precise. However, I think it is absolutely essential to create diagrams with adequate tools. (...) I have already seen PowerPoint templates for use case diagrams here. Totally off the mark, but people actually do this. [i8, Middle Manager, BITS].

Repeated efforts to introduce company-wide guidelines that conform to established modeling standards have failed so far:

"Our software actually has a fantastic object model. However, it is not yet established at all to create a simple UML profile for that, such that one could use standardized tools instead of drawing lines and circles. […] Most people still draw their diagrams with PowerPoint. An object is a circle in PowerPoint! Why not a simple UML profile with a stereotype?" [i21, Technical Lead]

In sum, these findings reveal that content created in PowerPoint is to a certain extent always ambiguous and allows for interpretive flexibility. While this may be desirable in some circumstances, e.g. when embracing multiple interpretations is necessary, it can be detrimental in others.

Synthesis S2:PowerPoint affords individual clarification during the production of slides, but also affords interpersonal complication during the consumption of slides.

Analogously to its freeing and captivating qualities (cf. section 4.1), PowerPoint's clarifying and complicating qualities constitute two contradictory yet interrelated elements that exist simultaneously and persist over time, i.e. a paradox (Smith and Lewis 2011). Contrary to the coping strategy we identified in the Freedom/Captivity paradox, namely temporal and spatial separation, we observed that innovators apply a different coping strategy to the Clarity/Ambiguity paradox. A temporal and spatial separation is possible, but would not resolve the Clarity/Ambiguity paradox in a satisfactory manner. Instead, innovators at BITS and CustomSoft respond to this paradox with acceptance, namely by embracing its tensions and appreciating their differences (Poole and Van de Ven 1989).

To begin with, it is again important to note that PowerPoint's clarifying and complicating qualities both have beneficial and detrimental effects on innovation practices. Clarifying the essence of an idea is crucial for making decisions on which direction to take in the innovation process, but oversimplification can backfire when it leads to overestimating the idea's maturity and underestimating the necessary completion effort. Here, PowerPoint's sequentiality and modularity afford structuring thoughts and focusing on essential aspects, but users should be frank and honest about the limitations and avoid overselling. Complicating things is undesirable for innovation in many instances, as misinterpretations induce flawed decisions and cripple collaboration. However, embracing flexible interpretations can trigger valuable input from stakeholders with different viewpoints, and hence help to identify previously not considered tensions in some instances. Here, the semantic ambiguity and interpretive flexibility of content created in PowerPoint strongly limit the degree of achievable clarity.

A temporal and spatial separation of the Clarity/Ambiguity paradox would reveal that different people perceive PowerPoint's clarifying and complicating qualities to varying extents at different settings in different points in time. For instance, individual PowerPoint users promote their own sense making process when producing slides, thus clarifying essential aspects for themselves. This works for small groups who accomodate their conflicting views by collectively producing clarifying PowerPoint slides in workshops, too. However, this should not be the final step, as those who later

consume these slides without having participated in their production will quite likely be exposed to misinterpretations. It can help to write down important aspects in a proper text document, but there is no guarantee that this conveys the message unambigously to all stakeholders either, as this strongly depends on the communication skills of the sender, and the cognitive capacity of the receivers.

Our findings suggest that the co-existence of clarifying and complicating qualities in PowerPoint cannot be resolved satisfyingly, and hence, innovators purposefully accept and embrace flexible interpretations. In the same way as natural language can be used for clarification but is never unambiguous, there are no formal semantics for creating content in PowerPoint that would enable unambiguous communication. PowerPoint-created content usually conforms to natural language semantics, at best, and natural language is inherently ambiguous. As with using natural language, using PowerPoint may help some people to obtain a clear common understanding, especially if they are focused on the target audience, but ambiguities and flexible interpretations cannot be avoided. Hence, our findings show that innovators cope with the Clarity/Ambiguity paradox by accepting the tension between the opposing poles, and appreciating their differences.

These findings sparked a heated debate about the consistent usage of adequate tools in the case companies. For instance, BITS initiated efforts to increase the quality of modeling practices by introducing BPMN to model the most important business processes in the core product - with considerable resistance. Even now, at the time of writing and some time after we completed our data collection, the observed PowerPoint practices persist, and we would critically question whether they would ever disappear completely. The dilemma is that prescribing clear guidelines on which tools to use and which modeling language to apply will quite likely foster resistance, as people feel constrained in their freedom (cf. section 4.1). But without clear guidelines, consistent usage is very difficult, if not impossible. An approach that allows people to freely express ideas in the tools they prefer while simultaneously ensuring consistent usage would be necessary here.

3.4.3 PowerPoint Paradox 3 - Scarcity/Abundance

A third paradoxical situation that emerged from our case study at BITS and CustomSoft concerns the management of innovation-related knowledge created and captured in PowerPoint. On the one hand, we found that PowerPoint, by constraining the amount of displayable information and offering limited functionality, affords the creation of concise, high-level illustrations that fit on one slide. We observed that people at BITS and CustomSoft learned to do more with less, making a virtue of the relatively scarce range of PowerPoint functions, seeing its limitations as an exercise to illustrate no more and no less than the essential aspects of an idea on one slide. On the other hand, we found that PowerPoint affords a strong tendency toward creating overloaded, overly aesthetic, and overly numerous slides. With the sequentiality of a potentially unlimited number of slides that a PowerPoint document can contain, people tend to produce many many slides to elaborate a complex topic. We learned that especially unexperienced users tend to overload slides with content, and with numerous formatting functions that distract from the content. Not only can a PowerPoint presentation contain an unlimited number of slides, but the file can also be copied, disseminated, and stored an unlimited number of times. These files can contain an abundance of information which is only to a limited extent automatically processable. We observed that managing an abundance of PowerPoint files became a real innovation bottleneck at BITS and CustomSoft. We term this the Scarcity/Abundance Paradox and examine it in the following.

Thesis T3 ("Scarcity Thesis"): PowerPoint's limited functionality and limited space per slide afford information scarcity by constraining the amount of displayable information.

In the previous sections, we elaborated on the point that PowerPoint's captivating qualities help innovators to focus on the essence of ideas, and thereby support clarification. As we argue in the following, taking a closer look on the limited amount of displayable information in PowerPoint is a good starting point for understanding a third paradox, namely the co-existence of information scarcity and information abundance in PowerPoint.

As we learned from our case study, creating, externalizing, disseminating, and internalizing knowledge is an essential aspect of innovation processes at BITS and CustomSoft. Since PowerPoint plays an important role in all of these practices, it is worth examining its affordances from a knowledge management perspective in more detail.

To begin with, PowerPoint slides have a fixed format that is optimized to fit on a screen or a sheet of paper. Unlike other presentation tools (e.g. Prezi), PowerPoint does not allow zooming in or out on slides in the presentation mode. It is possible to zoom in on a slide up to 400% in the editing mode (in Microsoft PowerPoint for Mac), though, and hence, it would theoretically be possible to fit up to four times more content on a slide by using smaller fonts and objects. In practice, however, we usually do not observe such usages, because navigating on such heavily loaded slides is cumbersome in PowerPoint, plus such slides would be highly unpleasant (if not impossible) to read in the presentation mode. Hence not surprisingly, all PowerPoint presentations in our case study conform to the standard format, exploiting the limited available space in a human-readable manner, but to varying extents. Many participants criticize PowerPoint's limited capacity to convey larger amounts of complex information, as exemplified here: "*Presentations have one large limitation: You can only illustrate what fits on the slide.*" [i75, Program Manager, CustomSoft].

Moreover, recall that the semantic representability of objects created in PowerPoint is very limited and makes it difficult to capture complex relationships. Hence, semantic mappings between concepts cannot be represented in PowerPoint at all, which creates an additional barrier to the amount of representable information, as exemplified here:

> *"I use whatever we've got available. I map my scribbling into PowerPoint slides that will basically look like process maps. I take snapshots of those, save them as graphic files, and put them on a set of linked Confluence pages. Ideally, I would have liked to have linked the hierarchy of maps together, but image mapping is impossible."* [i46, Technical Writer, BITS]

Notwithstanding the limited range of available functionality in PowerPoint, we yet again observed people at BITS and CustomSoft making a virtue out of this necessity by alienating PowerPoint as flexible and interactive design tool for collaboration with customers and partners. Here, in fact, the limited (and widely known) functionality of PowerPoint reduces complexity for less technically versed users. Hence, PowerPoint

allows people with different levels of technical expertise, with different degrees of specializations, and from different social worlds to collaborate on a common object. In such settings, it would be easier to use simpler, lightweight tools with limited functionality than special purpose, heavyweight tools which may give the designer greater flexibility but are not suitable in interaction with customers, as exemplified here:

> *"Customers really like to make changes. And with PowerPoint, you can create visual prototypes relatively quickly and easily on a reasonable level. You can also send them around. They run everywhere. And everybody can change them. And, especially at the beginning of a process, you often have to deal with the managers: They like to give feedback. But they really do not like to make a fool out of themselves. If you give them an Axure(-based prototype) you will never get anything out of it, except a frustrated customer who cannot operate it. But if you give them a PowerPoint prototype and they can draw around a bit in it, then they are totally happy that they could also contribute in a tool they know."* [i73, Product Manager, CustomSoft].

In a nutshell, the scarcity thesis states that PowerPoint affords information scarcity through its strongly limited functionality and ability to convey more complex information.

Antithesis AT3 ("Abundance Thesis"): PowerPoint's digitality, integrability, and sequentiality afford information abundance through potentially unlimited (re)production, dissemination, and storage of slides.

As we further learned from our case study, managing knowledge that is captured in the various innovation-related documents is crucial to maintain an overview. Since a larger share of these documents are PowerPoint presentations, we were also eager to find out how well these can be managed at BITS and CustomSoft. The short answer is: Not so well.

First and foremost, we observed that the sheer amount of PowerPoint presentations and slides therein can be overwhelming. Particularly when groups collaborate on a presentation, many participants complain about the limited control and structured support for collaborative work practices in PowerPoint. One major disadvantage is the lacking possibility to restrict create, read, update, and delete operations on PowerPoint

presentations other than on the document level. Neither is there a structured versioning support. Hence, in practice, people who collaboratively work on PowerPoint presentations tend to work around this drawback by creating many backup copies. As digital artifacts, PowerPoint presentations can easily be copied, shared, and stored an unlimited number of times. In addition, PowerPoint presentations can be integrated in a number of intranet web applications, for instance as online slideshows in Atlassian confluence, which is part of the intranet in both BITS and CustomSoft. Of course, this increases the number of PowerPoint presentations to a level that quickly exceeds what is tolerable, as exemplified here:

> *"That is a horror for me. (...) If you somehow work with PowerPoint, then you will have ten copies of everything, because everybody wants it just a bit differently and everybody has a slightly different version in a slightly different location. (…) Anywhere where non-IT-people are involved, where it moves more toward business and management and sales, they just do not have structured working practices. (...) Everybody just copy-pastes everything, every single time."* [i42, Technical Consultant, BITS]

In the second year of our case study, BITS introduced a groupware solution based on SharePoint in response to our study's findings about the employees' growing need to collaborate on documents such as PowerPoint:

> *"We were doing a team presentation and we each had our own little section in a set of slides, and just trying to manage that was such a hassle. We were all sending our updates to each other, merge that and (so on). I would say a Google docs collaborative system, or SharePoint would have been ideal for that."* [i46, Technical Writer, BITS]

While it would technically be long possible to use office web applications like SharePoint or Google docs, a number of barriers hinder BITS from fully overcoming the PowerPoint abundance. Apart from the not to be underestimated technical complexity of configuring a SharePoint solution, legal obligations prevent the company to store just any kind of document on cloud servers. After all, many BITS employees deal with very security sensitive customer information and are legally obliged to conform to restrictive banking security laws. Hence, we do not expect that the problem of PowerPoint abundance can be fully solved in the long run at companies like BITS.

A further problem with capturing much innovation-related knowledge in many PowerPoint presentations is the lacking possibility to algorithmically search and

prioritize PowerPoint files with respect to their importance. Unlike websites that can be connected with hyperlinks, which enables algorithms like PageRank to search and sort content according to their relevance for a given search term, PowerPoint does not provide functionality to semantically link objects, slides, or presentations. Quite surprisingly, some programmers at CustomSoft worked around this problem by hacking a PageRank-like algorithm that is also able to find links between PowerPoint slides if they conform to predefined semantics. However, this of course works only for PowerPoint slides on the intranet platform of CustomSoft.

In addition to the abundance on the document level, we found that the slides themselves are often overloaded, too. The exaggerated level of detail on many PowerPoint slides was a popular subject to mockery in our case study, as exemplified here: *"I've never seen a company where so many details are on a slide. Obviously, if you understand that slide you understand it all, but sometimes PowerPoint just goes too far"* [i47, Product Manager, BITS]

Hence, for many participants, it is a challenge to satisfy the information needs of various stakeholders on the one hand, and to not to provide too much information on the other hand, as exemplified here: *"When I make slides, they are of course always very full and deep, and the opponent usually does not understand that. It is difficult to maintain all these slide sets for the techies, the requirements engineers, the user experience designers, the politicians, and what not."* [i75, Program Manager, CustomSoft]

Particularly novice users are prone to overload slides, exaggerating with the amount of decorations and animations that distract from the essential content. In addition, we observed that especially technical people tend to overstep the expected level of detail, as exemplified here:

> *"They tend to use these PowerPoint slides with masses of bricks in the wall, and each one has got little labels, and it means absolutely nothing. (...) It is not clear, it is not helpful. It really blinds you. (...) You cannot see the wood for the trees. It is just too much. (…) I find myself doing exactly the same thing, (…) giving them too much information. (…) I know it is a temptation especially to technical people to explain everything they understand. You get carried away."* [i53, Software Engineer, BITS]

In sum, the abundance thesis states that PowerPoint's digitality, integrability, and sequentiality tempt user to produce, store, and disseminate an overwhelmingly high

number of PowerPoint presentations that are difficult to manage. In addition, it is difficult to find information in the abundance of PowerPoint documents because search engines cannot semantically process the content. This poses a real challenge for the knowledge management at BITS and CustomSoft.

Synthesis S3: PowerPoint affords scarcity of high-quality information on the slide level and, thereby, affords abundance of low-quality information on the document level.

We have observed instances where PowerPoint affords information scarcity, and instances where PowerPoint affords information abundance. These conflicting yet interrelated elements exist simultaneously and persist over time, which again classifies as a paradox (Smith and Lewis 2011).

A spatial separation (Poole and Van de Ven 1989) of the Scarcity/Abundance paradox reveals that scarcity and abundance are interrelated and coexist on different levels of PowerPoint. Quite ironically, it is indeed the scarcity of representable high-quality information on the level of a PowerPoint slide that induces the abundance of low-quality information on the level of PowerPoint presentations. Because the representability of available information is strongly limited on each slide, people tend to need many slides to support a complex argument, leading to a fragmentation of coherent content. This has detrimental effects on the management of innovation-related knowledge. It remains a challenge for organizations like BITS and CustomSoft to systematically create, externalize, disseminate, and internalize knowledge. In our case study, the extensive use of PowerPoint in these practices generated more problems than it solved. PowerPoint presentations have major limitations as a knowledge repository, because without semantic representation, relevant PowerPoint documents are hard to search and categorize. Even if someone is lucky enough to find the desired PowerPoint presentation, the context is often missing.

3.5 Discussion

In the previous section, we developed three PowerPoint paradoxes from the insights obtained in a case study of digital innovation practices at BITS and CustomSoft. We also identified ways for coping with these paradoxes. In a nutshell, we provide a dialectical

synthesis of three paradoxes developed from the practical insights obtained in a case study of digital innovation practices at BITS and CustomSoft and thereby provide an explicit answer to the guiding research question of this paper, namely *what role does using PowerPoint play in digital innovation practices*?

3.5.1 Implications for Research

This paper integrates and extends literature on PowerPoint and digital innovation. The main contribution of this study is a novel and empirically grounded conceptualization of paradoxes that result from using PowerPoint in digital innovation practices, along with a set of coping strategies. Our dialectical examination of PowerPoint's enabling and inhibiting qualities shows that the tool cannot be simply characterized as either beneficial or detrimental for innovation. In doing so, this paper adds to the growing body of knowledge on digital innovation and the role of digital artifacts like PowerPoint therein. We contribute to digital innovation research by identifying a set of paradoxical practices afforded by flexible digital technologies like PowerPoint. These paradoxes contribute to a better understanding of digital innovation itself by shedding more light on emergent practices and challenges innovators face in this complex process. Our contribution further adds to literature on PowerPoint by juxtaposing the benefits and drawbacks of using PowerPoint in a digital innovation context, which itself is still a largely unexplored terrain. Not least, our contribution lines up with a series of studies that use a paradox lens to develop encompassing theories of dualities of flexible digital technologies in practice.

We want to provide thought provoking impulses for scholars that are interested in understanding and improving digital innovation and PowerPoint usage in organizations. The three PowerPoint paradoxes can be seen as an allegory for several dilemmas resulting from the ongoing digitalization of innovation processes in organizations (as formulated by Yoo et al., 2012, 2010). The freedom afforded by digital technologies also implies certain constraints that hold people captive. The same technology can open doors to new forms of innovation practices in some situations, and restrict the possibilities of innovators in other situations. Nevertheless, PowerPoint plays an important role in a variety of innovation practices at organizations like BITS and CustomSoft. After years of extensive appropriation and deep entanglement into

everyday work practices, PowerPoint is strongly anchored in people's consciousness today. This consciousness results in an a priori agreement (cf. Introna and Ilharco, 2004) on using PowerPoint as communication medium in many situations, and our study reveals a variety of resulting social orthodoxies around PowerPoint. The widespread strong expectation to use PowerPoint allows innovators to present and discuss ideas without the necessity to first establish a common understanding of the discussion format. Thus, PowerPoint is an indispensable component of digital innovation practices, and the here identified PowerPoint paradoxes can actually be seen as paradoxes of digital innovation, which is characterized by dillemas resulting from the open and flexible affordances of digital technologies (Yoo et al., 2010).

The first paradox is the *Freedom* and *Captivity* afforded by PowerPoint's malleability and related social orthodoxies. PowerPoint does not prescribe narrow semantics and users can express themselves freely, constrained only by the limited available space per slide, the template, and the lacking semantic representability. But the latter has fatal consequences for innovation practices in the software industry, as it does not satisfy the requirements for the structured, formal, and automatable working practices of software engineers. Nevertheless, PowerPoint is a popular choice for creating objects that satisfy the information needs of several intersecting social worlds, i.e. boundary objects (Levina and Vaast, 2005; Star and Griesemer, 1989). As our data shows, the distinctive malleability, modularity, and sequentiality of PowerPoint fits the emerging character of digital innovation, as described by Yoo et al. (2010, 2012). In this context, people tend to prefer general tools over specialized tools particularly when various stakeholders with different roles are involved (Carlile, 2002). Contrary to many specialized tools, PowerPoint provides greater freedom of expression and facilitates the seamless transition between representing an idea on a slide and in the envisaged idea, for instance when complementing prototyping with UI mock-ups. However, we have also learned that PowerPoint use can run up against its limits and result in negative outcomes for innovators. The routinized use of PowerPoint might inhibit more creative practices such as free hand drawing or simply talking to each other freely. This can be particularly detrimental when using PowerPoint to brainstorm early ideas already, and afterwards people stay in the same medium all the time. The forced sequentiality of a PowerPoint presentation increases the distance between speaker and audience, leads to

a tendency to defer questions to the end, and therefore reduces the speaker's responsiveness to the audience (Yates and Orlikowski 2007), inhibiting creative discussions and improvisations (Gabriel 2008). The irony is that the individual benefits from PowerPoint's *freedom* while the *captivity* does collective damage, although the tool is intended to facilitate a group process, namely presentation and discussion.

Various social and technical measures to overcome PowerPoint's captivating qualities have gained considerable prominence, but have not yet been adopted extensively. Social measures include Apple's and Amazon's complete PowerPoint prohibition in creative workshops. In Switzerland, a public initiative even advocated a referendum for a nationwide PowerPoint prohibition - without success, but with considerable popular consent. Debating the desirability and viability of such radical social measures is out of the scope of this article, but we would suggest not ignoring the positive sides of the opposing poles in the Freedom/Captivity paradox. Technical measures include the emergence of plug-ins (e.g. PowerMockup, yUML, eDraw) that expand the constrained PowerPoint standard template and offer structured import/export possibilities for software diagrams and prototypes created in PowerPoint. Our study reveals further unused potential in the semantic enrichment of objects created in PowerPoint, but we would argue that the success of such technical measures depends strongly on the existence of a digital technology platform (Yoo et al. 2010) for PowerPoint that enables an easy and widely applicable configuration of such plug-ins. However, this is inexistent at the time of writing and thus, at BITS and CustomSoft, no such technical measures were consistently implemented.

The second paradox is the *Clarity* and *Ambiguity* afforded by PowerPoint's modularity, sequentiality, and interpretive flexibility. As our study shows, PowerPoint plays a crucial role in negotiating with relevant stakeholders because innovators can use the tool to persuasively display facts that do not yet exist. Over and above, the digital PowerPoint documents can be shared easily, and are thus often a decisive catalyst in mobilizing ideas (cf. Kaplan, 2011; Stark and Paravel, 2008). However, that same persuasiveness can backfire when the audience overestimates the idea's actual degree of completion. Because the expected format of a PowerPoint presentation is often a sales pitch, presenters tend to signal a preparedness that overshadows the idea's actual degree of maturity. Thus, ambiguities and misunderstandings may arise when

PowerPoint presentations do not provide sufficient information on the idea's actual state per se, especially when the author is not present. PowerPoint documents are not intended to be used in isolation, but rather accompanied by oral explanation. Nevertheless, we observed that PowerPoint slides are often the main documentation medium (cf. Schoeneborn, 2013). As PowerPoint expands to ever more functions in a variety of practices (such as documentation, software modeling, or prototyping) the tool approaches the status of a universal business language (Gabriel, 2008; Schoeneborn, 2013). Indeed, our data shows that PowerPoint has reached a level of acceptance which sometimes resembles a social coercion. On the one hand, this lets innovators benefit from network economics (Yoo et al., 2010) when using PowerPoint, because a variety of stakeholders with different backgrounds can be reached. As such, our study not only offers deep insights into how employees use PowerPoint in digital innovation, but also helps explain why PowerPoint is so predominant. Due to the digital nature of PowerPoint, the drawings can be shared with others without many intermediate steps, and through a variety of digital channels, e.g. chat, mail or wikis. On the other hand, the ongoing expansion of PowerPoint's use contexts often causes misinterpretations that result from diverging expectations (Yates and Orlikowski, 2007). For instance, PowerPoint documents that serve the dual purpose of presentations and project reports miss the information requirements of either. Similarly, our analysis of PowerPoint usage for modeling and prototyping shows that the same usage pattern can be very successful in one context, and a failure in another. In this regard, our examination of PowerPoint's role in digital innovation integrates well with recent discourses that focus on what happens when human practices take a technology beyond the purpose of its initial use (DeSanctis and Poole, 1994; Faulkner and Runde, 2009). Again, it is ironic that PowerPoint, originally intended to facilitate making a powerful point, affords *clarity* for individuals and *ambiguity* in group settings.

The third paradox is the *Scarcity* and *Abundance* afforded by PowerPoint's digitality, integrability, and sequentiality. As our study shows, innovators often make a virtue out of a necessity by using PowerPoint's limited functionality and limited amount of displayable information to structure thoughts and focus on the essence of an idea. Extant studies see this mainly as a disadvantage, and a considerable number of scholars criticizes PowerPoint for affording information scarcity. For instance, data visualization

expert Edward Tufte noted that even simple statistical facts are very cumbersome to display on PowerPoint slides, because the fixed format and limited available space per slide would complicate the representation of data that would otherwise be easily displayable in a table, if contained in a proper text document (Tufte, 2003). Similarly, human-computer interaction expert Clifford Nass argued that PowerPoint tempts users to focus only on outcomes, but not on the process of creating knowledge, which is why more complex arguments would be impossible to force into the fragmented, sequential, linear, and rectangular limited PowerPoint slides (Parker, 2001). While our data confirms these negative effects of PowerPoint-induced information scarcity, we also want to emphasize the positive effects, such as stronger focus and simplicity of use, which can lead to simplification of complex issues. Moreover, whereas some prior studies mention in passing an abundance of PowerPoint documents in organizations (Kaplan, 2011; Schoeneborn, 2013), our findings offer new insights on what happens in large organizations that face the challenge of managing information abundance resulting from vast amounts of unstructured but important knowledge captured in PowerPoint. In our study, PowerPoint played the role of a vessel for knowledge that was hard to organize. More recent technological developments like web-based collaboration platforms (e.g. Google Doc or SharePoint) are certainly a step in the direction of improving versioning and searchability, but our study reveals that better support to semantically link PowerPoint presentations, slides, and objects is necessary. Moreover, at the time of writing, it is hard to determine whether and how such collaboration platforms will completely replace traditional forms of collaborating over PowerPoint documents. Our findings suggest that such PowerPoint practices like the use of E-Mail, which has not diminished despite the emergence of many novel and more sophisticated communication channels, are persistent in organizations.

In a nutshell, our study shows that PowerPoint should not be seen as a static part of an organization, but rather as integral part of innovation practices that is enacted within a larger whole. In turn, digital innovation should also be seen as a bundle of dynamic practices where PowerPoint plays an important mediating, but dual, role. Yates and Orlikowski (2007) pointed out that affordance and constraint of digital technologies cannot be considered as alternatives (a dualism), but rather as two sides of the same coin (a duality). From this perspective, the here developed paradoxes reflect the dual

role of affordance and constraint in that they emphasize the ambivalences of PowerPoint's enabling and inhibiting qualities in an innovation context. Indeed, our contribution goes a step further by illustrating how a flexible digital technology can afford and constrain *contradictory* practices. It follows that a digital artifact like PowerPoint cannot be judged simply against its advantages and disadvantages. Instead, using PowerPoint generates distinctive tensions that require a critical dialectical examination to describe the phenomenon and identify appropriate coping strategies.

3.5.2 Implications for Practice

PowerPoint supports innovators throughout the whole innovation process. For instance, when visualizing ideas that can be presented without many intermediate steps, when creating working documents, diagrams, and models that are collaboratively shared among the project team in and via PowerPoint, in customer walkthroughs, and for aiding sales pitches, management summaries and high-level conceptualizations. In this vein, our study has practical implications for companies innovating in the increasingly digitized world (Yoo et al., 2012) in that it illustrates the tradeoffs of using PowerPoint and creates awareness of the challenges and opportunities. Our contribution helps individuals and organizations that experience PowerPoint paradoxes to recognize and cope with these in a consructive manner. This includes being aware of the different settings and points in time where the opposing poles of the paradoxes occur. Our study helps understand why practitioners refuse to use the many available (semi-)formal, specialized software tools. From a cost-benefit consideration point of view, one should critically question the practical value of (often expensive) purpose-specific tools for prototyping and software modeling that are rarely used. In practice, general purpose tools like PowerPoint seem to prevail despite striking disadvantages. At the same time, one must be aware that using PowerPoint until the point of intolerability leads to negative consequences, such as path dependencies, lock-in effects, and high susceptibility to error because of the low degree of automatization. Companies that face this challenge need to find an approach that allows people to communicate openly without prejudging the outcome while simultaneously ensuring uniform usage that ensures some consistency of the resulting content. Our data points to unused potential regarding the semantic representability of PowerPoint-created content that fits

the requirements of software engineers' structured working practices. Not least, our contribution informs designers that, when designing support for digital innovation practices, one needs to bear the dual role of digital artifacts in mind.

3.6 Conclusions and Outlook

The present study explores two software companies' digital innovation practices and focuses particularly on the important role of PowerPoint therein. The data shows that PowerPoint affords a variety of paradoxical practices that go beyond the software's intended purpose of editing and presenting slides. We had the unique opportunity to obtain in-depth access to the interpretations of people that are directly immersed with the phenomenon in practice. We seized that opportunity to critically reflect on the observed use of PowerPoint in digital innovation practices. This paper dialectically examines the often ambivalent and sometimes contradicting perceptions of people who use the tool, adressing the guiding research question: *what role does using PowerPoint play in digital innovation practices?*

This paper theorizes three PowerPoint paradoxes using grounded theory methodology to interpret an extensive qualitative data set gathered during a case study of digital innovation practices at two software companies. The three paradoxes each constitute two contradictory yet interrelated propositions that exist simultaneously and persist over time (Smith and Lewis 2011). The first paradox juxtapposes PowerPoint's provided freedom and captivity, and emphasizes how PowerPoint gives users a high amount of perceived freedom, but also holds them captive. The second paradox dialectically examines PowerPoint's provided clarity and ambiguity, and foregrounds how PowerPoint affords clarification, but also complication. And the third paradox capitalizes on the parallel facilitation of information scarcity and information abundance in PowerPoint. Reflecting on these three paradoxes with the help of Poole and Van de Ven's (1989) suggested coping strategies and related literature, this paper identifies a set of coping strategies that involve temporal or spatial separation, and acceptance.

In sum, seeing PowerPoint as ready-to-hand, transparent, deeply entangled component of digital innovation practices reveals that the tool often remains subliminal, routinized and imperceptible when used. Against this backdrop, this study shows how

a careful examination of such a mundane digital artifact as PowerPoint can reveal complex, multifaceted, and interesting insights for information systems researchers and practitioners. However, while using PowerPoint brings certain benefits, it equally comes at a cost. Through its paradoxical affordances and constraints, PowerPoint contributes to the ongoing democratization and digitalization of innovation processes by giving people at all hierarchy levels a voice through their creation and dissemination of PowerPoint slides (cf. Kaplan, 2011). But the extensive use of PowerPoint in organizations also generates a number of problems, such as inhibited creativity, misinterpretations, and poorly manageable knowledge. Since digital innovation practices are still a largely unexplored terrain, this paper provides a practical example of how an in-depth artifact analysis (here: PowerPoint) can deepen our understanding of the underlying practices, and the relationship between the two. After all, it is not the technology that makes a difference, but how it is used.

We conclude this article by asking some novel, interesting questions for future work that arise from the questions that have been answered here. Since the goal of this study was to deeper understand and conceptualize the sometimes paradoxical situations that digital artifacts generate in innovation practices, we chose qualitative methods and inductive theory building to identify and describe the phenomenon. Our study focuses on two case companies and a single technology to create rich insights into the observed phenomenon. In doing so, our in-depth analysis of PowerPoint use at BITS and CustomSoft shows that digital artifacts have important implications for innovation practices in the software industry. Part of our contribution is to condense these rich insights in a way that makes them transferable to a broader class of companies who share common basic assumptions with our two case companies. These include software companies that encourage employees to innovate and engage in interdisciplinary IS development, as well as industrial manufacturers, telecommunications corporations, consulting firms or financial service providers, which today have large software development branches, too. Future studies may examine if the here illustrated use of PowerPoint is specific to software firms or applicable in other types of organizations (such as consulting firms or universities and research institutions). It could also be interesting to examine the affordances of other artifacts (such as prototypes or social media) in a digital innovation context in more detail. Moreover, further quantitative

studies could develop metrics and test the suggested relations and their relative effects, for instance in laboratory experiments or with surveys.

This paper conceptualizes PowerPoint paradoxes in digital innovation practices at two European software companies, both culturally innovative but not necessarily global innovation leaders. Whereas these insights offer possibilities to deeper understand digital innovation practices and the role of PowerPoint therein, they alone do not offer comprehensive prescriptions on how to support these practices *ideally*. Instead, part of this paper's contribution is to clarify the paradoxical role of PowerPoint in digital innovation practices and to provide a critical dialectical examination. Future behavioral field studies may examine how leading innovative companies engage in digital innovation practices to identify best practices and structured guidance for innovation. Moreover, future design-oriented studies may develop and evaluate artifacts that support the here specified practices, as well as further develop PowerPoint to better support the here identified practices.

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4 When Prototyping Meets Storytelling: Practices and Malpractices in Innovating Software Firms

(CONFERENCE PAPER)

Raffaele Fabio Ciriello, Alexander Richter, and Gerhard Schwabe
University of Zurich, Binzmühlestrasse 14, 8050 Zürich, Switzerland
ciriello@ifi.uzh.ch, arichter@ifi.uzh.ch, schwabe@ifi.uzh.ch

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Abstract: Storytelling is an important but often underestimated practice in software engineering. Whereas existing research widely regards storytelling as creating a common understanding between developers and users, we argue that storytelling and prototyping are intertwined practices for innovators to persuade decision makers. Based on a two-year qualitative case study in two innovating software firms, we identify and dialectically examine practices of storytelling and prototyping. Our study implies that storytelling and prototyping should be integrated together into software engineering methods.

Keywords: Prototyping, Storytelling, Innovation, Practices, Malpractices, Case Study, Software Engineering

4.1 Introduction

In software engineering, prototyping and storytelling are widely regarded as distinct but related approaches to support requirements elicitation and validation (Budde and Zullighoven, 1990; Hickey and Dean, 1998; Kordon and others, 2002; Overmyer, 1991; Parnas and Clements, 1986), idea experimentation and exploration (Bäumer et al., 1996; Carleton and Cockayne, 2009; Doll, 2009; Kelley, 2001; Lichter et al., 1993), facilitating communication (Budde and Zullighoven, 1990; Lichter et al., 1993), and decision making (Lichter et al., 1993; Schneider, 1996; Urban, 1992). However, existing research regards storytelling merely as creating a common understanding between developers and users in the sense of use cases and usage scenarios. Here we report on an in-depth qualitative case study of software prototyping in an innovation context within two Swiss software companies. Our data shows that innovators combine prototyping and storytelling to persuade decision makers and transfer implicit knowledge.

Prototyping is a complex, multifaceted activity whose outcome depends on many factors, such as form and function of the prototype (Lim et al., 2008), how it is used (Houde and Hill, 1997), by whom it is used (Bryan-Kinns and Hamilton, 2002), and various context factors such as project setup, development approach, organizational environment, and infrastructure (Bäumer et al., 1996). We studied and observed prototyping and storytelling practices for over two years in depth via a case study involving extensive interviewing, observation, and collection of documentary material. We observed that a key problem in innovating software firms is communicating ideas purposefully to different audiences. This requires skillful use of communication tools like prototypes to persuade and collaborate with relevant stakeholders ((cf. Ciriello et al., 2014)). Thus, we address the question: *How do people communicate innovative ideas with software prototypes?*

Our contribution informs software engineering scholars and practitioners about the importance of prototyping and storytelling in organizations. We identify a set of practices that help to better understand the role of prototyping and storytelling for communicating ideas, persuading decision makers, and transferring implicit knowledge. An important practical implication is that storytelling and prototyping are deeply intertwined and should thus be integrated together into software engineering methods

like agile software development. When combined and integrated into agile software development, prototyping and storytelling can increase customer involvement and satisfaction through early, continuous, and frequent delivery of working software (i.e. prototypes and the stories inextricably bound to them), facilitate close, co-located, and periodical cooperation between business people and developers (effectively by means of stories), and improve product simplicity.

4.2 Related Work

4.2.1 A Practice Perspective on Innovating Software Firms

Developing innovative software systems is risky and failure-prone, but essential for software firms to thrive and survive in a dynamic and globalized market (Eisenhardt and Tabrizi, 1995). Prototypes can help to innovate with reduced cost and risk, as they support the early clarification of relevant problems and serve as a basis of discussion and further development (Budde and Zullighoven, 1990). However, we know yet relatively little about the many roles of prototyping as a practice to support the communication about innovative ideas in organizations. Here, an *idea* is defined as an underspecified, abstract conception of an envisaged product in someone's mental model, i.e. an intangible and volatile image in the mind of a person (Partridge, 1991, p. 303f) Ideas often originate from problem-solving engagements (Desouza, 2011, p. 25ff). Only when somebody communicates an idea, it meets the realm of reality and becomes a germ cell of innovation (Ciriello and Richter, 2015). Hence, we adopt a practice perspective to highlight how people use prototypes to communicate ideas, allowing us to better understand the role of prototypes in developing innovative software. When referring to *practices* in this paper, we refer to materially-mediated sequences of human activity centrally organized around shared understandings (Schatzki et al., 2001).

4.2.2 Software Prototyping

A *software prototype* (in the following just *prototype*) can be defined as a model of an envisioned software system that provides a basis for discussion, clarification, decision-making, experimentation, and learning between different stakeholders (Budde and Zullighoven, 1990). Prototypes represent ideas and simultaneously highlight and exclude aspects that are deemed critical or unimportant, respectively (Holmlid and

Evenson, 2007; Houde and Hill, 1997). *Prototyping* can be understood broadly as a practice to develop, demonstrate, evaluate, modify, and experiment with prototypes (Floyd, 1984; Lichter et al., 1993). Prototypes differ in *fidelity*, i.e. the prototype's closeness to the 'original', most commonly understood as the degree to which the prototype's visual refinement accurately represents the appearance and interaction of the envisioned system, not the accuracy of code or other attributes invisible to the user (Rudd et al., 1996). Low-fidelity prototypes (e.g. sketches, wireframes, or paper prototypes) are useful when a team tries to identify requirements, whereas high-fidelity prototypes are useful to create living specifications (Rudd et al., 1996). Prototypes can be represented as breadboards, presentation prototypes, functional prototypes, or pilot systems (Bäumer et al., 1996; Lichter et al., 1993). *Breadboards* are used as proof-of-concept to investigate technical aspects in the back-end system (Lichter et al., 1993) (e.g. system architecture, algorithms, data processing) and are not normally evaluated by end users (Bäumer et al., 1996). *Presentation prototypes* provide a concrete preview of an abstract idea (Lichter et al., 1993) by illustrating how the envisioned system may solve given requirements and focus mostly on the user interface (Bäumer et al., 1996). *Functional prototypes* implement only the critical features with which the user needs to work in essence (Bäumer et al., 1996; Lichter et al., 1993). And *pilot systems* are working systems that can be practically applied but still need technical finalization to count as a full system (Bäumer et al., 1996; Lichter et al., 1993).

Prototypes are useful for requirements elicitation and validation (Budde and Zullighoven, 1990; Hickey and Dean, 1998; Kordon and others, 2002; Overmyer, 1991; Parnas and Clements, 1986), idea experimentation and exploration (Bäumer et al., 1996; Carleton and Cockayne, 2009; Doll, 2009; Kelley, 2001; Lichter et al., 1993), facilitating communication (Budde and Zullighoven, 1990; Doll, 2009; Floyd, 1984; Lichter et al., 1993), and decision making (Lichter et al., 1993; Schneider, 1996; Urban, 1992).

Requirements Elicitation and Validation: Because it is often not until the finished system is in use that users are able to explicitly formulate their system requirements (Budde and Zullighoven, 1990; Parnas and Clements, 1986), prototypes can reduce time, risk, and cost of software development projects while improving quality and usability through iterative cycles of requirements elicitation and validation in early phases (Bäumer et al., 1996; Hickey and Dean, 1998; Kordon and others, 2002; Overmyer, 1991).

Prototyping allows users to see and interact with a prototype, and to provide more constructive and detailed feedback (Budde and Zullighoven, 1990; Davis, 1992; Schneider, 1996).

Idea Experimentation and Exploration: Prototyping helps to explore and experiment with ideas in early innovation project phases (Carleton and Cockayne, 2009), especially in the software industry where new product developments are characterized by high uncertainties and risk (Doll, 2009; Eisenhardt and Tabrizi, 1995). By prototyping their way to a solution, teams can learn-by-doing what works and what not (Bäumer et al., 1996; Doll, 2009). As prototypes embody implicit and explicit design hypotheses that can be tested (Schlachtbauer et al., 2013), the creation of knowledge about problems and potential solutions is often seen as their raison d'être (Davis, 1992; Lichter et al., 1993). The outcome of such a process is often a prototype contaning just the essential features for validated learning, also called a Minimum Viable Product (MVP) (Blank, 2013).

Facilitating Communication: Prototypes can support and enrich coordination, communication, interaction, and motivation among various stakeholders (Bäumer et al., 1996; Doll, 2009; Floyd, 1984). Prototyping requires mutual coordination between developers and users throughout the entire development process (Gutierrez, 1989), with each group continuously acquiring knowledge about the work practices of the other (Budde and Zullighoven, 1990) and about the role the new system plays in the user's life (Bäumer et al., 1996; Rudd et al., 1996). Prototypes provide a concrete basis for communication between users, developers, and decision makers. They support discussions of particular problems, clarification of particular questions, or preparation of particular decisions (Budde and Zullighoven, 1990). When used in social interaction, prototyping can spark creativity (Kelley, 2001) and is helpful for externalizing and representing ideas (Bäumer et al., 1996; Lim et al., 2008). In addition, they play an influential role in generating and motivating teams that are bound together by the common purpose of fulfilling the prototype (Doll, 2009).

Decision Making: Prototypes can be used to sell ideas (Voss, 1985), prevent misunderstandings (Bäumer et al., 1996; Schneider, 1996), assess risks (Urban, 1992), and gain insights about feasibility, desirability, and viability (Bäumer et al., 1996; Lichter et al., 1993). Thus, they influence decision making in ways not possible for written reports (Bäumer et al., 1996; Schneider, 1996). Awareness of the needs of the

different stakeholders and their views on a prototype is crucially important for decision making. Different audiences have different roles in the joint activity of prototyping, and thus bring different perspectives and interpretations to a prototype (Bryan-Kinns and Hamilton, 2002).

4.2.3 Storytelling

Storytelling can be simply understood as the communication of ideas, beliefs, and experiences via stories (Oaks, 1995; Schreyögg, 2005). A *story* can be defined as an account of actions that is formulated from authentic events, either real or imagined (Gershon and Page, 2001; Uittenbogaard, 2013). Stories comprise characters, whereby there is usually one character (the "hero") the listeners identify with. Their structure consists of a beginning, middle, and an end, that is held together by a plot (Hayne, 2009). The sequence of actions can unfold in time or thematically (Meyer et al., 2005).

In recent years, storytelling has gained importance as a technique for contextualizing information in business and technical domains, like knowledge management (Meyer et al., 2005; Schreyögg, 2005; Swap et al., 2001) or software development (Clausen, 1994; Gershon and Page, 2001; Uittenbogaard, 2013; Wende et al., 2014). In an organizational environment, a story can be understood as a detailed narrative of past actions and interactions of employees and managers that are communicated informally within or across organizations (Swap et al., 2001). Stories are an inherently appealing form of communication that outperforms other formats in terms of memorability, learnability, persuasiveness, and ability to bind different communities together (Swap et al., 2001). Because they are more vivid, engaging, entertaining, and easily related to personal experience than specifications, rules, or guidelines, stories are more likely to be internalized, acted upon, and guide behavior (Swap et al., 2001). In addition, stories encode rich contextual details, which makes them suitable carriers of implicit knowledge (Swap et al., 2001). For instance, video stories facilitate seeing and hearing the characters and the environment in which they are situated, and thus add further cues and detail (Wende et al., 2014).

In software development, stories can be superior to more abstract use cases or usage scenarios because they are more vivid and thus effective for getting the attention of people (Uittenbogaard, 2013). Listening to people's stories helps to understand their

needs, and crafting them together helps to shape the vision of a desired system (Uittenbogaard, 2013). Several attenuated forms of stories have been introduced into software development practice to explore and define a system's requirements. For instance, use cases are sequences of actions that describe how a generic actor or user interacts with a system, usually as a list of short, written steps [36]. And usage scenarios describe real-world situations of how people interact with the system, usually in the form of short prose involving various personas, steps, events, and/or actions that occur during the interaction (Wende et al., 2014). Usage scenarios can be problem-oriented descriptions of the current state of affairs, activity-oriented descriptions of broadly defined actions the user performs with the system, or interaction-oriented description of detailed actions (Rosson and Carroll, 2002).

A good story complements a prototype in ways that cannot be achieved with traditional use cases and usage scenarios. Use cases and usage scenarios offer a brief statement of the requirements, usually comprising technical details of work packages or features to be implemented. Their purpose is essentially to map user requirements to system requirements, and to facilitate communication between users and developers (Wende et al., 2014). In turn, stories provide a detailed, narrative illustration of the situation in a real context, thus enabling a high-resolution understanding of the involved people, along with their reasoning, interests, desires, needs, and environmental context (Clausen, 1994; Gershon and Page, 2001; Uittenbogaard, 2013). Their purpose is in essence to provide rich context and map envisioned ideas to enacted ideas. Stories facilitate interaction between innovative employees and decision makers, such as managers in their formal role or even users or peers in their informal role when they support decisions with feedback (Swap et al., 2001). Stories help designers to make detailed descriptions of human living people during the design process and can be used to give people an orientation (Clausen, 1994). The promise of introducing storytelling in the system development process is to use the potential of flexible interpretations (Clausen, 1994). A story that is interesting, appealing, and well-positioned in relationship to the real-world experience of decision makers can be a tremendously helpful means to persuade people and communicate an idea effectively (Uittenbogaard, 2013). It can help designers, users, customers, and developers to understand how the

idea will change the existing situation in that it facilitates communication and shared understanding between stakeholders (Wende et al., 2014).

In sum, there is a research gap concerning the roles of prototyping and storytelling in relation to the communication of innovative ideas in organizations. Existing literature sees storytelling merely as creating a common understanding between developers and users, in the sense of use cases and usage scenarios. Thus, the role of storytelling in relation to prototyping remains unclear and underestimated, particularly when communicating ideas to persuade decision makers and transfer implicit knowledge. Thus, we address the guiding research question: *How do people communicate innovative ideas with software prototypes?*

4.3 Research Method

This research is situated within a larger study of innovation practices in the software industry. Over the course of more than two years (02/2013-12/2015), we obtained and sustained in-depth field access to two Swiss software companies, where we engaged in substantive interviewing, participant observation, and collection of prototypes and related documentary material. Our study is exploratory in nature. Following the principle of concatenation, we used the emerging findings of an initial study on idea communication to feed the next sub study (Stebbins, 2001). More specifically, we realized that prototypes played a vital role in processes of generation, communication, negotiation, and development of ideas. This led us to analyze the prototyping practices in detail. We embarked on an iterative journey of data collection and analysis until we identified the key theme, namely the role of storytelling in software prototyping.

4.3.1 Research Relationship with the Case Companies

We selected two different kinds of companies, one product company and one project engineering company, to study them in depth and compare prototyping practices across different organizations. Both companies are characterized by a large percentage of employees who graduated from one of the leading computer science departments in the world.

Banking and IT Solutions (BITS): For more than 20 years, the traditional business model of this company with around 1400 employees has been the development,

distribution, and operation of its proprietary core banking system. After the executive board became increasingly concerned that the lifecycle of this product might have peaked, BITS took various extensive measures to develop new products and services in the areas of mobile banking, outsourcing, financial services, and consulting. Our style of involvement with BITS was that of a closely involved researcher having in-depth access to data, issues, and people, who viewed the researcher as one of 'them', trying to make a valid contribution to the field site (Walsham, 2006).

Custom Software Engineering (CustomSoft): For almost 20 years, the core business of this company with around 350 employees has been the development of and consultancy for custom business software in segments including transport, health, space agencies, public administration, banks, and insurances. CustomSoft recently initiated efforts to rethink its business model from a project engineering to a product company to reduce the financial risk stemming from the company's high dependence on client orders. The style of involvement with CustomSoft was that of an outside observer who was not seen as having a direct personal stake in various interpretations at outcomes, with personnel frankly expressing their views (Walsham, 2006).

4.3.2 Data Collection and Analysis

The first author conducted 95 semi-structured interviews ranging from 19 to 104 minutes (average 60 minutes) with experts involved in recent innovation projects at BITS and CustomSoft. By interviewing a wide range of participants with differing roles and from different units we were able to seek out and document multiple interpretations of the actions under study (Klein and Myers, 1999, p. 77). The author used a semi-structured interview guide to ensure topical focus and consistency while also allowing respondents to freely express their own views. We recorded and transcribed all but two interviews to capture a full description of what was said and facilitate later in-depth analysis. Through these interviews, it was possible for us to step back and access the interpretations of the fellow participants in more detail (Walsham, 2006). We wrote up detailed interview notes within a day.

Following the idea of triangulation (Silverman, 2006, p. 291), we relied on multiple sources of evidence, compiling multiple interpretations obtained from interviews, observations, field notes, and documentary material into a coherent picture (Klein and

Myers, 1999). For instance, we collected and analyzed 17 prototypes and related documents that participants sent us. In addition, the author conducted a series of participant observations at formal gatherings (meetings, workshops, presentations and fairs) and informal gatherings (lunches, impromptu meetings) in the context of the innovation projects, spending in total 211 full days at the research sites between 2013 and 2015. Where possible, photographs and field reports complemented the observations.

We carried out the data analysis collaboratively relying mostly on interview transcripts, collected documentary material, and field reports. The interviews were recorded, transcribed, and processed using MAXQDA, where two researchers developed a codebook to facilitate joint analysis and increase confidence in the findings (DeCuir-Gunby et al., 2011). Two additional researchers carried out coding checks to ensure intercoder reliability and develop a shared conception of reflection (DeCuir-Gunby et al., 2011), through which we identified key themes.

4.3.3 Structured Literature Analysis

Parallel to the case data collection cycles, we conducted a structured literature analysis in which we followed the well-established framework by Vom Brocke et al. (vom Brocke et al., 2009). Hence, we conducted the five generic steps: *1) definition of review scope 2) conceptualization of topic 3) literature scope 4) literature analysis and synthesis 5) research agenda*. Steps 1-2 followed from the field study in which we identified research topics and the scope, namely the role of storytelling in software prototyping. In step 3 we searched on ACM digital library, AIS electronic library, and Google Scholar for the keywords "software, prototype, prototyping, storytelling, narrative, scenario, development, engineering", selected 68 sources from reading the titles, abstracts, and introductions. We then proceeded with the snowball technique, selecting further texts from the references cited in the sources and synthesized them into the literature review in section II (step 4). We finally framed the research agenda (step 5) by moving back and forth between data and literature, interrogating field material to check whether the data supported emerging claims, and whether literature helped us to make sense of the empirics (Yanow and Schwartz-Shea, 2013).

4.4 Results

This section provides detailed insights into the observed storytelling and prototyping practices in our case study at the two Swiss software companies BITS and CustomSoft. As shown in table 1, we group the practices into four categories: *Choosing the Script, Determining the Level of Detail, Engaging with the Audience, and Spreading the Message*. The categories represent essential aspects of prototyping and storytelling that emerged from our iterative analysis and interpretation of the data. Each category comprises a dyadic pair of practice and malpractice, which we examine dialectically in the following.

Table 4-1 : Overview of Practices and Malpractices

Category	Practice	Malpractice
Choosing the Script	Holding an "I Have a Dream" Speech	Telling Fairy Tales
Determining the Level of Detail	Presenting an "Elevator Pitch"	Using a Sledgehammer to Crack a Nut
Engaging with the Audience	Crafting the Story Together	1) Take It or Leave It 2) Premature Closure
Spreading the Message	Coupling Prototype and Narrative	Running from Pillar to Post

4.4.1 Choosing the Script

The script or plot is the structure that holds the story together and defines the sequence of actions that unfolds. This is a decisive factor of a story's success or failure and the narratives around a prototype should be chosen accordingly to accurately reflect real world situations of actual users.

4.4.1.1 Holding an "I Have a Dream" Speech

A good practice is to hold an *"I Have a Dream"* speech, i.e. using prototypes to show how one can bridge the difference between the current status quo ("what is") and the future desirable state ("what could be"), along with a call for action to implement the idea. For this purpose, the storyteller needs to pick up the listeners in the world they live in and take them on a promising journey to a bright future. One observed challenge in this context is that not all potential users are trained to think in the same abstract categories like software professionals are. Here prototypes can be helpful as visual aids

to provide living examples and speak the listeners' language. For instance, the mobile banking suite project team at BITS used a photo story to show how the prototype could make payment, wealth management, and real estate purchases easier on mobile devices. After inviting senior managers of various Swiss banks to learn about the product idea, several of them showed interest in the future product. The program manager remembers: "*The customers were excited. They understood: These are people with ideas. [...] Of course, we raised high expectations, for which to be fulfilled one has to wait several years, but the message to the market was important: We want to go in that direction". (I25)* An innovation partnership with several banks came about and, as a next step, the project team developed a functional prototype. Then, they sent the CEOs of the banks an iPad with the prototype app installed as a Christmas present. This was reportedly an effective instrument to help the listeners understand where the journey would lead to and in the end, the project was successfully developed and implemented. One software engineer remembers: *"[the prototype] was insofar helpful that they could see 'ah, that's how it could look like.' [...] The sole looking and touching already helped to explain what we wanted to show.*" (I1).

4.4.1.2 Telling Fairy Tales

A malpractice for choosing the script is to tell *Fairy Tales*. While prototypes can be compelling backbones of a story, one should pay close attention to how close the told story actually reflects a real-world situation in the listener's experience. For instance, the mobile banking suite project team once conducted a workshop with a private bank where they used the prototype to walk the customer through a seemingly illustrative user scenario. In this case the scenario was how a bank customer uses the app to finance the purchase of a new house. But then, the client advisors of the private bank protested that this is not even a real use case because their wealthy customers do usually not lend money to buy a house. They are rather more interested in optimizing cash flows in their portfolio. One project member remembers: *"Having the abstraction ability to see that instead of buying a house you could do the same thing with cash flows was already somehow difficult. So, the closer you are to the real life situation of the client advisors, the better." (I1).* This implies that the storyteller should carefully choose the content of the story presented as context of the prototype. Our data revealed several cases of "dummy data" (e.g. "lorem ipsum" texts) leading to confusion, because the story was harder to

interpret. While listeners may sometimes tolerate discussing over a prototype that looks sketchy and unfinished, they rarely tolerate any deviation from real life situations in a story. Hence, prototyping may involve stubs, sketches, and mockups to a certain extent, yet the story that is told behind must not be fictional but as close to reality as possible. In one workshop, a team of developers at BITS learned the hard way that using dummy data can have serious drawbacks: *"There were 30 people in the room [...] and everybody could see how it would look like in the end. That was good. At the same time, it was bad that we had dummy data in it, [because the sponsor] took it too seriously. [...] For us, it was only dummy data, arbitrary strings, could also have been the names of Beatles songs. But [the sponsor] insisted on it until we explained that it was only a string, not relevant for what we wanted to show. And in the end we created a set of test data with which the developers could then work for long. That was the positive aspect of all that." (I28).* These drawbacks can be even more severe when the users confuse the prototype with finished system and underestimate the necessary effort to finalize the development. If the storytellers do not make transparent what is 'behind the scenes' of the prototype, they do not only risk getting less constructive feedback, but they also risk raising false expectations among listeners and ultimately disappointing them: *"I made some HiFi clickable prototypes. [...] The executive board saw that and immediately raced around and said: 'In one week we go online with that!' [I thought:] 'Ah! Panic! There was nothing programmed, no HTML-code whatsoever, the whole implementation in the CMS, nothing was there.' And then, well, we could not stop it anymore. We had to take night shifts to bring the whole thing online just in time somehow."* (I82). In short, innovators should be careful that a) the context is as close to reality as possible and b) the prototype is not misunderstood or misused as the final system.

4.4.2 Determining the Level of Detail

The level of detail of the story being told is a critical issue. Including many details (e.g. actors, steps in the sequence of action, high fidelity of the prototype) may be tempting but may bore or confuse the target audience (especially managers and decision makers who are busy and want to focus on the essential idea aspects).

4.4.2.1 Presenting an "Elevator Pitch"

One observed way to choose the level of detail effectively is to present an *"Elevator Pitch"*, i.e. when the storytellers include only the central details that are necessary to

understand the key idea in as little time as an elevator ride. One CustomSoft software engineer told us of a small prototype app for a table soccer game. He regularly discussed it with his colleagues during lunch to decide what should be the next features to bring a benefit and what should be excluded. He reflects on this experience as follows: *"For me, the ideal artifact is a prototype, as lean and light as possible, such that I can gather quick feedback, but also as fat as necessary, such that you can see the idea." (*I85*)*

4.4.2.2 Using a Sledgehammer to Crack a Nut

A malpractice to determine the level of detail is *Using a Sledgehammer to Crack a Nut*, i.e. when irrelevant aspects are over-engineered and relevant aspects are neglected. Especially technically versed developers are at risk of building something just for the sake of building. Instead of developing a minimum viable story that contains just the necessary core aspects that are required to show how the idea creates value for the audience, people tend to put unnecessarily high efforts in technical gold-plating of solutions to ideas that are not yet well thought through: "*We are so used to building huge applications for lots of money. But actually, it takes much less to show an idea."* (I85). Although some study participants are aware of potential advantages of storytelling over gold-plating, they consider the main barrier to be a lack of writing skills and relatively high effort of writing a story clearly and concisely. For instance, one lead developer states that a good story is far more laborious than a prototype "*because you have to write it well." (*I11). Hence, not everyone agrees that the benefit of storytelling is worth the effort. One lead developer even states that it would show him that the employee already spent too much time on the idea if a well elaborated story would be the first thing the employee came up with. Here, it may help if storytellers are explicit about the purpose of storytelling. Managers usually wish for conciseness when ideas are communicated to them. As one interviewed manager argues, it is crucial that the storyteller is able to explain the main benefit clearly and concisely in few words: "*Many ideas are not presented concisely enough. People talk a lot but sometimes it needs just one precise sentence."* (I31).

4.4.3 Engaging with the Audience

Storytelling in the context of software prototyping should not be confused with a frontal presentation. Instead, we observed that it is a crucial factor how the storytellers engage and interact with the audience.

4.4.3.1 Craft the Story Together

One good practice to engage with the audience is to *Craft the Story Together*. Here people use prototypes to attract potential customers or users, to keep them interested by continuously showing progress, and to obtain input on the current state of the prototype. For instance, one successful innovation project at BITS started when a major Swiss cantonal bank posted a public tender for a fund management system. A prototype played an important role to sell an idea and persuade a funding decision, but also to act as a common object of work to craft a story together. Making use of the fact that the bank was already a long-standing customer, a team at BITS created a working prototype in the form of a new module in the existing system that was already implemented at the bank. Being able to demonstrate with a living example how the solution would look like, and to show an early proof-of-concept with a working prototype, BITS had a major advantage over its competitors and convinced the sponsors at the bank to win the bid. The project leader reflects on this experience: "*If you want to convince a bank, you need a prototype. Slides are not enough [...] You should build a prototype as quickly as possible, such that you can talk to the customer soon. People need to see something. [...] Of course, a prototype is a higher investment, but it also has much higher persuasive power.* (I10)". As the innovation project continued, the project team used the prototype regularly to support continuous interactions in product review workshops with the customer, and to discuss possible design options internally. The project leader compares this experience with building a Lego house together: "*You add one or two bricks, remove some others, refine a whole chunk, then start with a new plate. [...] The whole idea is only a sketch until you build a prototype and validate it with someone who has the business knowledge. But unless you create something tangible, you never get to the next level.*". (I10) And when the first pilot product was rolled out to an initial set of test users, the prototype was useful to show the banking expert how the final product could be used. "*When you talk to a customer a prototype usually works best [because] it is always a challenge to*

understand what the customer actually wants. [...] It is easier if you just try to implement it briefly with a pilot-prototype and then say 'look, if you click here, than this happens, and in the end, it looks like that'. (I23).

Similarly, we found various cases at CustomSoft where prototypes were used to craft stories together with various stakeholders. In general, CustomSoft engineers report that using a prototype is in most cases the best way to present an idea to both internal and external stakeholders, because the quality of the feedback and interaction is much higher: "*I call this 'sounding'. You go there, make some music and see if the music goes down well or not. So, in principle, I could just go there, do a PowerPoint presentation, and say 'look, I have a super cool idea, this is how I imagine it'. And then there are bullet points, right? And then they say 'Well, thanks, um, we will see. Bye.' Or I go there and say 'now look at this'. Then I hand them a tablet and say 'now you can click and imagine you are sitting in a train, right?' Then they say: 'Wow! This is exactly what I imagined!'*. (I79) In sum, crafting the story together refers to how prototypes can be used to make a compelling case for the development of an innovative idea first and then, once a social coalition has been built, to co-create the story centering around the prototype together.

4.4.3.2 Take It or Leave It

A malpractice to engage with the audience is *Take It or Leave It,* i.e. developing something in a quiet chamber and then pushing it involuntarily to the user, often done by developers thinking they know best how the solution should look like. Our interview partners understand this practice is not ideal, but they report that it happens repeatedly. Their offered explanation is that, besides having to explore new terrain and constantly look for new markets to enter with innovative products, a company like BITS also must exploit the existing business and make sure that the current product portfolio runs stable to satisfy existing customers. More 'boring' tasks like release planning, responding to customer issues, fixing bugs, meeting new regulatory requirements, or maintenance usually determine the day-to-day business at BITS. Larger parts of the organization are explicitly devoted to keep the existing business running and stable instead of innovating. In such an environment, there is a risk that innovative ideas are assigned lower priority or even drown in daily business because they are naturally riskier. Such a state can frustrate many employees in the long run, especially the more

technically versed who often have a keen interest in new technologies and a natural inclination to creativity and curiosity. Perhaps because of these hurdles, we have encountered the rather dubious practice of *take it or leave it* quite frequently at BITS. We often observed that people decide to take their own initiative and conduct a 'submarine attack'. That is, they develop something at their own discretion in a quiet chamber, push it into the release and wait to see how the customer likes it. The result can be anywhere between exciting and horrifying for the customer: "*People simply build something, let the customer work with it and see what happens. What is generally considered rapid prototyping is that you build a prototype and get feedback before it goes live, but that's not how [they] build prototypes. Yes, there are some workshops and then they build what they understood there. But often, you do not have time for a second or third iteration, and then you go live with what you have.*" (I20) As a standard software provider, BITS always has the challenge that some features may provide value for some customers but can be counterproductive for others. When a submarine attack goes into the productive system, this can lead to undesired complexity or even violate regulatory requirements: "*under the cover of prototyping and pragmatism, people build and check in complete solutions without too many further considerations, and then the customers have to live with it. [...] Sometimes it works well, you're more efficient and all, but sometimes it creates incredibly high collateral damage [...] because it was implemented quick and dirty.*" (I20)

4.4.3.3 Premature Closure

Another malpractice to engage with the audience is *Premature Closure*, i.e. jumping to conclusions too early about what is to be built. As we learned from our study, it requires some courage and energy to challenge important stakeholders, especially sponsors, and thereby risk that an innovation project might be cancelled or not initiated at all. Even when they find an idea attractive, stakeholders often do not have the patience (or willingness) to support prototyping and experimentation for long, because this naturally implies high levels of risk and uncertainty: "*In such a project setting, the customers' willingness to prototype surely conflicts their willingness to have some specification, which you can sign and say 'this is what we get'. Ideally, you want to start with a rough prototype and refine it with the customer. [But] the customer, who pays for it and also wants to implement it in a year, insists on signing a binding document first.*" (I1). A typical challenge

in this situation is to find the right level of fidelity, such that the envisaged solution is concrete enough to be both feasible and desirable for all stakeholders while also not to narrow down the solution path too early and thereby waste innovative potential. One project team at BITS had to learn the hard way that committing oneself too early may save the project, but the final product will eventually not be used: "*We worked on this for a year, created prototypes and all. Now we come up with the final product and the customers say it is not quite what they expected. [...] It was way too abstract for them. They cannot grasp what it means if you do not show them exactly how it looks like*." (I12). Inherent to the immaterial nature of software products is the danger of confusing a prototype with a final system. This increases the risk of premature closure even further, because interactions with the audience may focus too much on unimportant issues while overlooking important ones: "*The customer cannot differentiate what is easy or difficult to change. Very often, we get tangled up in extremely tedious discussions about things that are completely irrelevant. Things like, it does not matter if we build that in green or blue. Then again, some things are not even brought to the table, because the customer thinks 'that's easy, that's just some workflow parameterization'. But there we have to say 'sorry, what you want is impossible, the whole server-construct is missing there'*." (I12). In addition, storytellers frequently overestimate their understanding of the listeners' real needs. When they lull themselves into a false sense of security about the requirements too early, the probability is high that the final product will not be satisfying. One experienced software engineer summarizes it as follows: "*At the moment, we spend a bit of time with the customer and the rest is development and testing. We should reverse that ratio and really challenge the customer. Certain things that are not worth building should simply not be built. [...] We should look much longer at the whole integration process on the customer side and build prototypes without code, just wireframes. And we should take these prototypes to the customers to challenge them until they are fed up and say 'this is what I really want' instead of only saying 'yes, yes' and then build something*." (I9).

4.4.4 Spreading the Message

Stories can be an effective way to build social coalitions. Thus, one important factor to consider when using prototypes for storytelling is also how to spread the message. There are a variety of ways how storytellers can spread the idea in a desired or undesired way.

4.4.4.1 Coupling Prototype and Narrative

A good practice to spread the message is *Coupling Prototype and Narrative*. A prototype can support and enrich the direct face-to-face communication between innovation teams and different stakeholders. By showing with a prototype how a finished system will look like in the future while telling a story, it is not only easier to explain complex issues, but it is also possible to create 'wow moments' to attract and persuade potential customers or users. One common challenge in this situation is that, after such an interaction, these people usually talk to other people about the state of the prototype and its underlying idea. One product owner at BITS calls this the 'indirect audience': "*The direct audience are those you present the idea to. But they take this to others and you must roughly know who these others are to know how to present your design.*" (I6). While it can be quite desirable that an idea spreads, we observed that it is important to couple together prototype and narrative such that the idea maintains its integrity while it spreads. Otherwise negative effects can occur, such as misunderstandings or even political unrest when people object or reject the idea before it is well thought out. Hence, the sender of an idea must have the indirect audience in mind and ensure that the idea is repeated consistently. An often observed way to couple together prototype and narrative is to create artifacts that not only show the prototype but also how it could be used. Ideally, the artifact itself tells the story in a concise and simple manner, such that one does not have to tell the same story again and again in different contexts. Additionally, one should pick a conventional file format that runs on the common platforms without requiring much technical expertise from the viewers. A simple and frequently used artifact in this context is PowerPoint. Because the tool is easy to use and widespread, it often serves as a container to couple together prototypes and narratives: "*If I do not narrate the prototype, it does not mean anything to you. So [I usually] make a PowerPoint presentation with screens of the prototype and descriptions what it does, so I can send it by mail [and] do not have to narrate it in person.*" *(I65).* However, PowerPoint presentations still have a high level of ambiguity. A more sophisticated, though somewhat more laborious, way is to create video films. These can either involve real actors showing how to use the envisaged system, or simply tutorial-like screens of the prototype with audiovisual explanations: "*We tried to tell the story in individual*

conversations, but we found out that this dilutes the message over time. So we made films [that show] how we imagine the next stage to look like. We put clickable prototypes into films such that the people, when they tell something internally, always tell the same story without having to make any 'soundtracks' for slides. We gave them readily assembled films with bubbles and all, which they could simply show on a [USB] stick and say 'this is how [it] looks today. This is how we think it looks tomorrow', such that the message stays stringently the same." (I75).

4.4.4.2 Running from Pillar to Post

In turn, one less effective way to spread the message is *Running from Pillar to Post*, i.e. trying to please all stakeholders equally. Budgeting and initiation processes of an innovation project typically involve interactions with sponsors and upper managers, but the later development and integration requires appropriate support from both internal and external middle management and employees. However, it is not conducive for a project team to try to satisfy all stakeholders equally. Instead, it is crucially important to be aware of how decision power is distributed among relevant stakeholders and give decision makers the necessary arguments at hand to convince others. For instance, the mobile banking project team told us an infamous anecdote of them trying to satisfy the conflicting demands of two different stakeholder groups, and then failing to meet both of them: "*The top management loved our design, but when we went to the middle management, they all said 'it has to look classic, we are doing boring e-banking here'. So we did that, went back again to the steering committee with the top managers, and they said 'how boring is that prototype?' [chuckles], and threw it out again*." (I17). This is especially the case when the listener is a sponsor who pays for the envisaged product, but not a user who works with the final product it in the end. "*We have this challenge that the product we build will not be used primarily by bankers, but by bank customers. And the banker in between is actually more of a problem than an aid. Because they have a different view than the customer on the banking business.*" (I25). Or if the management overlooks that developers have to support an idea, too: "*So I created paper prototypes and HTML UI prototypes, collected feedback that reinforced me to continue, [...] but at that point where it had to be implemented it was also a task for the developers. But the developers complained and did not want to do it, so suddenly there was no time and it was off the table.*" (I11)

4.5 Discussion

In the previous section, we provided rich empirical insights into observed practices and malpractices of prototyping in our case study, focusing particularly on the role of storytelling. In sum, prototypes can be a compelling backbone of a story and help to make a persuasive case for a desirable future (i.e. holding *I Have a Dream* speeches*)*, but it is crucially important that the script is as close to an existing or envisioned real world situation of the listener as possible (i.e. avoiding *Fairy Tales)*. Storytellers should use prototypes to focus the story's level of detail on highlighting only the aspects relevant to the listeners while leaving out irrelevant ones (i.e. telling *Elevator Pitches*) instead of gold-plating and over-engineering technical aspects of the prototypes that are not conducive to illustrate the core features (i.e. *Using a Sledgehammer to Crack a Nut*). *Crafting the Story Together* by using prototypes to attract listeners and to obtain feedback continuously is an effective way to engage with the audience, as opposed to pushing the listener to use something that has been developed in a quiet chamber (i.e. forcing them to *Take It or Leave It*), or jumping to conclusions about what the listeners really want too early (i.e. *Premature Closure*). And *Coupling Prototype and Narrative* can be an effective means to spread the message convincingly and consistently among stakeholders, while sparing storytellers the efforts of *Running from Pillar to Post* and trying to please everybody.

An important practical implication of our study is that prototypers need to see themselves as storytellers. The here identified set of practices can be used by software professionals as a guideline to enact storytelling and prototyping purposefully and simultaneously in practice. Our data shows that prototyping and storytelling are two complementary sides of the same coin. Both are essentially techniques for requirements elicitation and validation (Budde and Zullighoven, 1990; Hickey and Dean, 1998; Kordon and others, 2002; Overmyer, 1991; Parnas and Clements, 1986), idea experimentation and exploration (Bäumer et al., 1996; Carleton and Cockayne, 2009; Doll, 2009; Kelley, 2001; Lichter et al., 1993), facilitating communication (Budde and Zullighoven, 1990; Doll, 2009; Floyd, 1984; Lichter et al., 1993), and decision making (Lichter et al., 1993; Schneider, 1996; Urban, 1992). Prototyping can support and enrich the communication about innovative ideas and, if done properly, be a low-risk and cost-

efficient approach to develop innovative software systems. However, a prototype alone does not elicit and validate requirements, explore and experiment with ideas, facilitate communication, or make decisions by itself. Just as a picture can be worth a thousand words if we know what it shows, a prototype can be worth volumes of documents if, and only if, we know the story it is supposed to tell (Schneider, 1996). The prototype itself does not indicate what it does as it provides no explanations or judgements (Schneider, 1996). This knowledge cannot be fully explicated in the prototype alone, but rather resides implicitly in the minds of its developers, viewers, and users. When any of these stakeholders leaves the team or forgets lessons learned after the prototype is no longer used, part of the acquired knowledge that could have been useful in other contexts will be lost (Schneider, 1996). So far, research has mostly treated the construction, communication, and preservation of implicit knowledge as black box, overlooking the practices through which people enact these in social interactions with prototypes. In turn, storytelling has only ever been seen as a means to create a common understanding about as-is and to-be between storyteller and listener, in essence reducing stories to a bridge between developer and user in the sense of use cases and usage scenarios (Wende et al., 2014). Thus, existing literature can only provide few answers in terms of theoretical concepts, empirical insights, or let alone practical guidelines (Doll, 2009; Schlachtbauer et al., 2013).

We offer a distinct perspective in which storytellers are innovators who need to convince decision makers by combining the expressiveness of an illustrative prototype with the persuasiveness of an appealing story. Here, decision makers are understood as managers and sponsors in their formal role, but also as users, business experts, technical experts, and other peers who are consulted during the decision-making process with the goal to not only understand each other mutually, but also to persuade others. Thus, a good storyteller should ensure that the story has an interesting, appealing, and authentic script, highlights only the relevant aspect with respect to the intended audiences, and provides listeners with opportunities to shape the idea while also staying clear and consistent as it spreads.

Prototypes and stories both embody many different requirements details explicitly and implicitly, some of which are hard to divide (Swap et al., 2001). A prototype is the pivotal point of a story by means of which people can estimate potential impacts of the

envisioned system. In turn, a story provides rich context and conveys a lot of implicit knowledge. The story's level of quality and elaboration decides over whether the prototype is persuasive or not. In stark contrast to traditional use cases and usage descriptions, storytelling provides richer context and centers on the actual users instead of some generic customer (Wende et al., 2014). In addition, stories play an important role in communicating ideas within and across organizations. They help listeners to get a better understanding of the needs and desires of actual users and thus better support decision making. Storytelling with a prototype is an ideal situation to start a discussion focused on the problem and possible solutions.

Based on these insights, we suggest that storytelling and prototyping can and should be integrated into software engineering methods together. For instance, the here identified practices fit the principles of agile development, such as increased customer involvement and satisfaction through early, continuous, and frequent delivery of working software (i.e. prototypes and the stories inextricably bound to them), close and periodical cooperation between business people and developers (effectively by means of stories), co-located communication, and simplicity (Beck et al., 2001).

4.6 Conclusions and Outlook

The present study explores the role of software prototypes in communicating innovative ideas in organizations. Our data shows that storytelling should not be reduced to the sole function of creating a common understanding between developers and users, but should also be seen as complementary practice, at eye level with prototyping, that can be an important means to support decision-making, transfer implicit knowledge, and facilitate communication, requirements elicitation and validation, as well as idea exploration and experimentation.

Our case study results are obviously bound to two organizations to limit complexity and explore practices in depth. Future work could examine whether the held observed prototyping practices and malpractices are specific to software firms, or can also be found in various industries where innovating involves software development. It could also be interesting to compare which of the here observed practices also hold in a physical prototyping environment.

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5 Identifying Patterns of Idea Diffusion in Innovator Networks

(CONFERENCE PAPER)

Raffaele Fabio Ciriello, Daning Hu, and Gerhard Schwabe
University of Zurich, Binzmühlestrasse 14, 8050 Zürich, Switzerland
ciriello@ifi.uzh.ch
hdaning@ifi.uzh.ch
schwabe@ifi.uzh.ch

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Abstract: The diffusion of innovative ideas throughout a social network of innovators depends crucially on how people are connected and influence each other, and particularly on the advocacy of influential individuals. We contend that existing conceptualizations of innovation diffusion and peer influence do not suffice to capture the multi-faceted nature of idea diffusion. To address this challenge, we adopt concepts from both innovation management and social network analysis to identify patterns of idea diffusion. Using topology analysis and percolation analysis, we examine the impact of peer influence on the percolation of idea-related artifacts. We demonstrate the applicability of our approach using the preliminary results of our study with one of Switzerland's major independent banking software providers. The outcome will not only have valuable contributions to the studies of innovation management and social network analysis, but also make a methodological contribution by introducing the examination of artifact percolation to study idea diffusion.

Keywords: Idea Diffusion, Innovation Diffusion, Innovation Networks, Social Network Analysis, Innovation Management

5.1 Introduction

In today's ever-changing business environment, the companies stand out that manage to continuously enthuse their customers through innovative ideas while formerly prominent firms frequently fall back when they do not recognize the potential of disruptive ideas in time (cf. Christensen 1997). As innovation cycles shrink, ever more companies shift from traditionally centralized, R&D-oriented organizational structures to a decentralization of ideas and more flexible, cost-efficient, and network-based work structures, opening up the innovation funnel to both peripheral inside innovators and external collaborators (cf. Desouza 2011, pp. 7-15, Stoetzel and Wiener 2013). Nowadays, everybody can be an innovator in no time. Ever since Apple and Google launched their online app markets – the App Store and Google Play respectively – success stories of privately developed apps reaching millions of downloads outweigh each other. More and more companies recognize the potential of this innovation glut and leverage ideas from external sources. In this context, online social networks and corporate social media increasingly gain importance, attracting researches from various disciplines, particularly innovation management (IM) and social network analysis (SNA).

However, existing literature on IM focuses primarily on managing processes and establishing organizational structures that favor the generation of innovative ideas. Research on open innovation examines the usage of both inflows and outflows of knowledge to accelerate internal innovation and expand the market for external innovation (Chesbrough et al. 2005). In this context, the recently thriving literature on intrapreneurship emphasizes empowerment of front-line employees and management of innovations that come from all parts of the organization (Desouza 2011). Finally, literature on the diffusion of innovations focuses on how innovative ideas spread through the communication channels of a social system (Rogers 2010). However, these perspectives lack a deeper understanding of idea diffusion and the factors that favor it. Ideas do not simply cross communication channels themselves, but depend crucially on topology and dynamics of the underlying network, particularly on the distribution of influential and susceptible individuals, gatekeepers and promoters, decision-makers and operational staff, and their respective attitude towards the idea. Therefore, it is

necessary to examine these factors of idea diffusion from a network perspective. We contend that the missing link between the extent of idea diffusion, the level of advocacy for the idea within the underlying social network and the likely success of the innovation may lie in the way people are connected and influence each other.

On the contrary, network science has contributed a lot to better understand structures and dynamics in social networks, but lacks a deeper understanding of their respective impact on idea diffusion. Structural properties of information and communication pathways in social networks have been examined as a way to compare different kinds of communication dynamics in different networks (Adamic and Adar 2005; Eckmann et al. 2004; Kossinets et al. 2008). Finding that network topology and burstiness generally hinder diffusion, the dynamics of information spreading have recently been examined by Karsai et al. (2011). Aral (2011) and Iyengar et al. (2011) examine the role of peer influence and social contagion in new product diffusion – an approach that seems promising for the innovation diffusion discipline as well. As online social networks become increasingly widespread, understanding social contagion becomes not only more feasible but also more crucial (Sundararajan et al. 2012). Therefore, studying peer influence and social contagion is a promising approach to improve the way we conceptualize idea diffusion in innovator networks.

Identifying patterns of idea diffusion in innovator networks is considerably different from examining innovation diffusion. Whereas innovation diffusion examines the diffusion of completed products or services throughout companies, our goal is to examine the diffusion of ideas throughout social networks. In contrast to completed products, evolving ideas often exist only as an abstract conception in their developers' mental model, i.e. an image in the mind of a person (Partridge 1991, pp. 303-304), which is usually intangible and volatile. Additionally, ideas may result in a product or service at some point in time, but their diffusion happens much earlier. Due to the highly collaborative and iterative nature of idea development (Hartmann et al. 2013), difficulties arise particularly in the context of defining measurements of diffusion. Ideas do not only diffuse, but are constructed and negotiated in social interaction. The initial image in the mind will most probably change when one sees the physical image that answers to the idea of it. While recent studies (Aral and Walker 2012, Bakshy et al. 2012)

analyze information diffusion in Facebook, emphasizing the impact of individual factors such as peer influence, information dissemination and information exposure, idea diffusion is presumably determined by a series of factors that are more difficult to measure. To some extent, this might attribute to today's scarce usage of enterprise social networks (ESN) for the development of ideas, which would enable the conduct of similar network studies in the context of innovation. Moreover, idea diffusion comprises much more than the sheer diffusion of information. Since innovative ideas usually affect several business domains, diffusion obeys cross-disciplinary collaboration. Current approaches disregard the role of peer influence and social contagion in this context. Without a deeper understanding of these aspects, conceptualizing patterns of idea diffusion in innovator networks is hardly feasible. Our research aims to close this gap by unifying the perspectives of IM and SNA in a comprehensive approach.

To fulfill this objective, we are currently conducting a study with one of Switzerland's major independent banking software providers (in the following termed BITS – Banking and IT Solutions) – an industry highly depending on innovative ideas. By 1) analyzing social networks of innovators and organizational structures at BITS, 2) tracking the dissemination of innovation artifacts and 3) comparing different courses of idea diffusion in different social networks, we focus our discussion on these research questions:

1) What are the factors that facilitate the diffusion of innovative ideas throughout a social network of innovators?
2) By which patterns do ideas diffuse the communication channels of a social network of innovators?

In doing so, we seek to improve the way idea diffusion is currently conceptualized. Researchers from IM disciplines (particularly open innovation, intrapreneurship, and innovation diffusion) and researchers from SNA (particularly information diffusion, social contagion, and peer influence) will both benefit from this improved conceptualization as it facilitates the consolidation of their theories. Companies striving to further elaborate their innovation processes will also benefit from a deeper understanding of idea diffusion as it facilitates deducing guidelines on how to

maximize effectiveness and efficiency of communication channels and organizational configurations.

5.2 Related Work

5.2.1 Innovation Management (IM)

Literature on managing innovation has thrived since Henry Chesbrough (2003) introduced the concept of open innovation to academic literature. According to the open innovation paradigm, companies should purposefully use both inflows and outflows of knowledge to accelerate internal innovation and expand the market for external innovation (Chesbrough et al. 2005). This perspective on open innovation also embraces peripheral internal innovators as sources of innovation, i.e. employees inside an organization but outside the traditional R&D department (Neyer et al. 2009). Some refer to this as internal open innovation, as opposed to external open innovation with collaborators outside of the organization (Stoetzel and Wiener 2013). Internal open innovation is mainly driven by a "decentralization of ideas" (Desouza 2011, p. 8-14), causing companies to shift from traditional R&D silos to network- and community-based work structures. Since R&D departments usually only enable experienced employees to work on ideas with a long-term impact, ambassadors of intrapreneurship advocate the empowerment of front-line employees to facilitate collecting ideas from all parts of an organization. Being intrapreneurial refers to employees that "share the drive and zeal of entrepreneurs", but rely on resources provided by an organization (Desouza 2011, p. 34). They do so because they want to focus on developing ideas, but need the organization's support when it comes to providing technology resources, skilled team partners, established partner networks and financial or legal expertise.

Companies with a high intrapreneurial activity establish "environments of play" to foster employees' creativity (Desouza 2011, pp. 57-60). Prominent examples are the slides and fireman's poles in Google's offices (Brown 2008) and the "big atrium" in Pixar's central office (Rao et al. 2008). The building was constructed in a way that simply does not allow employees to finish their working day without running into their co-workers. This fosters collaboration and facilitates the flow of ideas across organizational units. To promote the flow of ideas, it is crucial to maximize channel

efficiency and effectiveness, as well as maintain their integrity in different contexts. "Ideas should take as few intermediary hops as possible on their way to a destination" (Desouza 2011, p. 57) to prevent them from being overly distorted by noise in the channels. Analyzing channel efficiency places a stronger focus on the structure and dynamics in the underlying social networks to understand how ideas really diffuse. Cantner et al. (2011) pursue this by examining innovation networks in regional knowledge bases. They analyze regional innovation networks based on patents and find that a specialized regional knowledge base tends to result in relatively fragmented network structures, which may strengthen the position of gatekeepers. However, their research focuses mainly on the output of three R&D departments in three different regions. Hence, other relevant organizational structures (especially decentralized, network-based ones) have not been thoroughly examined. Graf and Krüger (2011) examine the performance of gatekeepers in regional innovator networks. They found that being well connected both vertically (with internal innovators) and horizontally (with external innovators) in an organization has a strong positive effect of innovation success. Hence, the most capable intrapreneurs are those that a) excel in establishing a personal network of innovators (Desouza 2011, p. 72) and b) collaborate with central gatekeepers.

In recent years, the importance of communication channels has particularly increased due to the occurrence of new digital channels (Tuomi 2002) and the ongoing paradigm shift to the so-called attention economy (Davenport and Beck 2001, p. 20, Yardi et al. 2009). For example, while a couple of years ago the main goal was to be among the top search results in Google for your field of interest, the goal today is to maximize visibility by "going viral" through Facebook, Twitter and similar channels. This seems to have tremendous effects both on the way ideas are generated (maximize content luridness, maximize interactivity) and communicated (maximize linkage, maximize throughput). Rogers (2010, p. 35) distinguishes four main elements that influence the spread of an idea: 1) the innovation, 2) communication channels, 3) time, and 4) a social system. Our scope is to examine patterns of idea diffusion throughout a social system and the communication channels through which it is connected.

5.2.2 Peer Influence and Social Network Analysis

To examine topology and dynamics in innovator networks, we choose the SNA measures *clustering coefficient*, *proliferation*, *homophily*, *assortativity*, *percolation*, and *preferential attachment*. The clustering coefficient of a node A denotes the probability that two randomly selected connectors of A are connected, too (Easley and Kleinberg 2010, pp. 48-50; Rapoport 1953). A high clustering coefficient in innovator networks implies a small average path length between any two innovators. Proliferation represents the total number of innovators adopting an idea (Zhang et al. 2013). Homophily denotes the circumstance in which two connected nodes in a network share certain characteristics (Easley and Kleinberg 2010, pp. 86-90). Similarly, assortativity denotes the tendency to mix with similar nodes (Newman 2003). Innovator networks should ideally disclose low levels of homophily and assortativity as successful collaboration requires more complementary than substituting characters (Desouza 2011, p. 125). Percolation has been adopted from materials science, denoting the process of a liquid flowing through porous material. In SNA, percolation is often used to describe the social network's ability to let information spread. Finally, preferential attachment describes the network property that newly joining nodes tend to connect to nodes that are already well connected. Some refer to this as the "fitter get richer" phenomenon or "Matthew Effect" (Gay and Dousset 2005; Merton 1968). Small world networks tend to have a high clustering coefficient and hence small average path lengths (Watts and Strogatz 1998). Connections in scale-free networks follow a power law distribution, i.e. the k^{th}-most connected node has $1/k^{s}$ as many connections as the most connected one (Albert and Barabasi 2002; Zipf 1935). Power law distributions dynamically evolve in networks whose population grows according to preferential attachment (Barabasi and Albert 1999). Innovator networks tend to disclose high levels of assortative mixing and preferential attachment (Gay and Dousset 2005). Therefore, they are likely to comply with the scale-free network model. Since the scale-free network model is based on the aforementioned models of Zipf (1935), the findings of Vitanov and Ausloos (2012) support this assumption. By juxtaposing common approaches to study knowledge diffusion, they conclude that such models provide useful information for the analysis of idea diffusion in social systems.

In recent years, several studies have examined the impact of peer influence and social contagion on information diffusion (Aral et al. 2009; Aral 2011; Iyengar et al. 2011). Aral and Walker (2011) use randomized trials to identify peer influence in networks – an important step towards capturing what promotes social contagion. Other studies (Aral 2013; Aral and Walker 2012) emphasize the importance of the distribution of influential and susceptible members over the social network. Both the diffusion impact of influential members promoting an idea and susceptible members adopting it shall be examined. Bakshy et al. (2012) examine the role of tie strength in information diffusion. They find that weak ties "play a necessary role in facilitating information flow" (ibid) when information is shared exclusively between some nodes. This however seems to shift as information becomes more readily available. We contend that both an in-depth examination of network topology, including a characterization of tie strength, as well as a causal empirical estimation of peer influence are essential to better conceptualize the multi-faceted nature of idea diffusion. This requires finding suitable measures for influence, advocacy and tie strengths.

5.3 Research Design

To answer our research questions, we combine approaches from IM with methods from SNA to study patterns of idea diffusion at BITS. Starting with an analysis of the organizational configuration, we identify departments with a considerably high innovation activity and interview 32 experienced innovators. Questions address collaboration structures and the usage of artifacts in the development of ideas, focusing on concrete innovations that have been developed at BITS or that are currently in progress. In addition to our interviews, we extract relevant innovation artifacts and communication data from frequently used tools, such as intranet, company wikis, project management tools, issue tracking systems, and email. Based on this dataset, we model the innovator networks at BITS (one per idea) and identify dimensions that influence idea diffusion. Having constructed our model, we use topology analysis and percolation analysis to identify patterns of idea diffusion. Figure 1 illustrates this approach and the next sections present the single steps in further detail.

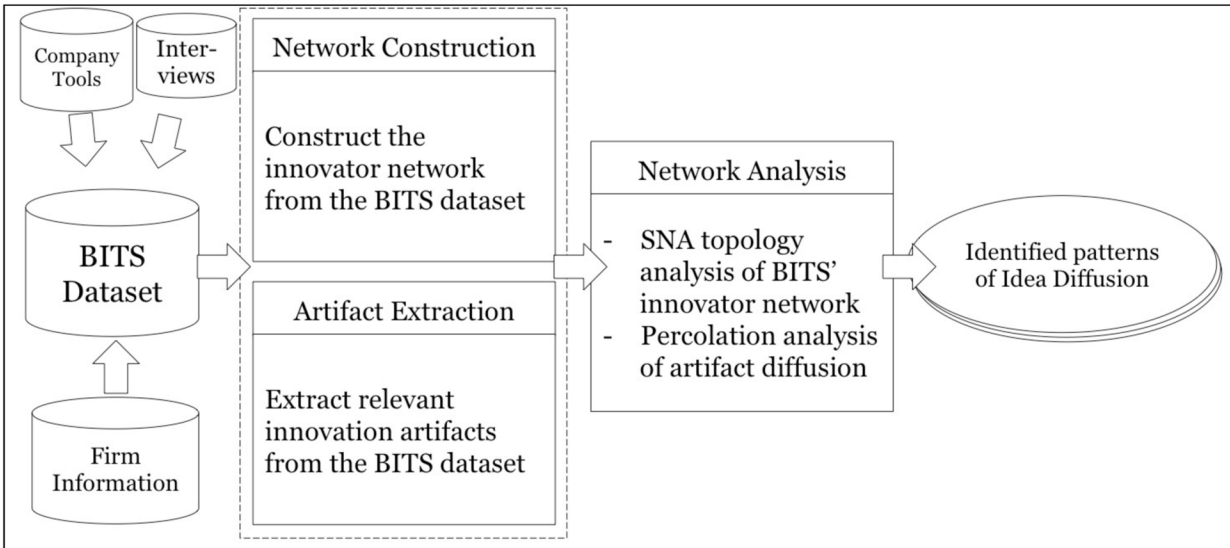

Figure 5-1 : Unifying the IM perspective and SNA methods into a comprehensive approach to examine patterns of idea diffusion

5.3.1 BITS Dataset

The core activity of BITS lies in the development and distribution of its house-own core banking system. Around 1000 employees in two development centers and seven subsidiaries worldwide collaboratively innovate with customers (mostly retail banks), partners (specialized units e.g. for technical or outsourcing problems), and universities. It is therefore an excellent subject for examining idea diffusion in innovator networks in the context of cross-disciplinary collaboration. We start by analyzing the organizational configuration of BITS in the context of innovation. The executive board of BITS has collaborated with us on fostering the innovation processes for about two years. Against the background of this previous collaboration, we regard the company as complying with an "advocate model" (Desouza 2011, pp. 33-43), in which the CEO and a group of established decision makers select from a pool of ideas. Some dedicated organizational units develop most innovative ideas (mostly software tools) for internal and external customers. Hence, we conduct semi-structured interviews with 32 experts from these innovative units of BITS, including both operational staff (software engineers, business analysts, technical writers etc.) and decision-making personnel (lead developers, software architects, project managers, division managers etc.).

Our questions address the role of the innovators at BITS, their collaboration with members from other organizational units (both internal and external), and in particular their artifact construction behavior when developing ideas. In doing so, we usually identify a series of concrete artifacts that are built and communicated throughout the innovator network. As these artifacts form concrete idea representations, their analysis and evaluation makes idea diffusion measurable. Artifacts at BITS come in all different shapes, such as scenarios, UI mock-ups, whiteboard sketches, wiki pages, use cases, customer tickets, executable prototypes and so on. Our interviewees provide us the physical or digital artifacts and grant us access to the relevant tools so we can mine for artifacts ourselves. The interviews are recorded and analogously transcribed. The transcriptions are imported into MAXQDA, a Computer-assisted Qualitative Data Analysis Software (CAQDAS). MAXQDA assists us in 1) constructing the network by linking the interview snippets where collaborators are mentioned with profile data of the corresponding collaborator, and 2) extracting the artifacts by linking the interview snippets where relevant artifacts are mentioned. After having collected all the relevant data, we construct the innovator networks as described in the next section.

5.3.2 Network Construction

We ask our interviewees about their role in the divergent (generating) and convergent (refining) phases of the development of concrete ideas. For example, if the interviewee affirms having actively promoted her own original idea, we ask her how and to whom she communicated it first, with whom she collaborated in shaping the idea, whether the idea was finally implemented, and so on. Furthermore, we ask about her participation in innovative projects, how the idea originated and evolved, how feedback was collected and processed, from whom it was collected, and how the recipients reacted to the adoption of the final implementation. In doing so, we gain valuable insights of the innovation activity at BITS and relevant projects about which we can then collect further data (see next section).

Drawing on these insights, we construct the networks of innovators as follows. For every idea that manifests itself in at least one concrete artifact, we construct the network of relevant innovators involved in its development. A node in the network is any

employee at BITS or one of its collaborators that 1) actively promotes the idea, and/or 2) is (potentially) valuable for the promotion of the idea because of relevant skills or decision-making authority, and/or 3) is affected by the impact of the idea. Collaborating nodes are connected via an edge. Different types of collaboration may include decision-making authority, regular interaction (e.g. team colleagues), needs-based casual interaction, and personal sympathy.

5.3.3 Artifact Extraction

From the interviews we have conducted so far, we have learned that a lot of idea-related artifacts are distributed over a series of company-wide collaborative software tools, such as the Confluence team and content collaboration tool or the JIRA project and issue tracking software. Quite often, further artifacts such as UI sketches, architectural diagrams, technical specifications or even executable software in the form of a link to a patch set in the Gerrit code reviewing system are attached to the Confluence pages, JIRA issues, or Email. The digital representation of these artifacts comprises a lot of meta-information such as creation date, revision history, authors, editors, and subscribers. This alleviates tracking collaboration efforts for an artifact, which also facilitates observing its diffusion. By mining these tools for artifacts related to the innovative projects we identified in the interviews, we seek to get a better grasp on how the idea diffused the innovator network through its relevant artifacts.

5.3.4 Network Analysis

Once we have constructed the innovator networks and extracted the artifacts, we apply topology analysis and percolation analysis using SNA centrality methods, which help identifying influential and susceptible members. High degrees usually indicate high innovation activity and peer influence (Hu and Zhao 2009). SNA measures such as the clustering coefficient, preferential attachment, link density, and homophily are examined to check the innovator network properties against the small world and the scale-free network model. We hypothesize the existence of a "percolation threshold" (Albert and Barabasi 2002) in innovator networks, i.e. a critical probability p_c below which the network is composed of isolated clusters, but above which a giant cluster

spans the entire network. We compare different courses of idea diffusion in different innovator networks to examine whether peer influence increases p_c, i.e. whether high levels of social contagion favor a so-called percolation transition. In a nutshell, we identify patterns of idea diffusion in innovator networks by examining the percolation of artifacts throughout idea-related networks.

To capture the percolation of artifacts, we examine the degree of diffusion and the advocacy as dependent variables. The degree of diffusion denotes the extent to which an idea is advocated in the underlying social network of innovators. It is a function of proliferation and advocacy (after Zhang et al. 2013). The advocacy variable refers to the overall degree of positive interactions and modifications that are executed by all innovators in the networks to promote the idea. Peer influence, homophily, time, quantity, and average tie strength are selected as independent variables. Peer influence is measured as a weighted linear-additive function of the exposure of innovator i to advocating the idea in the innovator network ($\Sigma_j w_{ij} a_j$) where w_{ij} captures how relevant each innovator j is to i and a_j indicates the advocacy of the idea by j. Time indicates the total amount of time it took from the generation of the first idea artifact until further diffusion finally stagnates, i.e. no more artifacts are generated or promoted. Quantity is measured indicates the total amount of idea-related artifacts that diffuse the innovator network. Average tie strength indicates indicates the communication intensity between any two nodes, e.g. number of emails, collaboratively developed artifacts etc. over the total number of edges.

5.4 Preliminary Results

In the first round of interviews, started with a thorough examination of the *AlphaInnovations* (AI) division, a dedicated organizational unit that arose from the need to extract the promotion of promising ideas from the overloaded *ProductEvolution* (PE) department and to establish an environment that favors innovativeness. Developing radically innovative ideas became a victim of PE's daily business (solving customer issues, give support, bug fixing etc.) in recent years, reducing the focus of its activity to incremental product development. As a result, one of the company's founders built up the AI division in order to pursuit a series of promising ideas that were stuck in the PE

department for too long. Many of the participants we have interviewed so far formerly worked for PE and joined AI to work on these ideas. We interviewed the founder and division manager of AI, the product manager of AI's solution portfolio, two software architects, three developer team leaders, four software engineers, a business analyst, and a technical writer, ranging from two years to two decades of experience with BITS. Today, the AI division consists of three large developer teams that collaboratively develop frameworks and modules that extend the core banking system (CBS) of BITS. The original CBS was initially developed more than a decade ago based on the programming language PL/SQL. As it became more and more cumbersome to extend the rapidly growing CBS due to a lack of modularization, the mission of the AI division is to tailor a middle tier and service layer for the monolithic system. Using the object-oriented programming language Java, the three developer teams seek to substitute legacy PL/SQL code with a modern multi-tier architecture step by step. Hence, the AI division can be seen as an innovation supplier for the PE department.

Many of our interviewees state that innovations at BITS mostly occur from the collaboration of few established innovators within the same department, but rarely from cross-departmental collaboration. When requesting resources for the development of innovative ideas, employees of BITS contact members of a recently established *IdeaBoard*, a dedicated organizational unit chosen to select from a pool of ideas. These members are mainly perceived as gatekeepers for innovations that candidate for crossing organizational borders. As AI's products are essentially extensions that do not have direct value in themselves without the existing core banking systems, the board members basically select ideas according to their potential value for PE's product portfolio. As a result, our interviewees describe the innovation trajectory as rather reactive than proactive, meaning that emergent ideas shall aim at improving the existing business incrementally, rather than changing it radically. Moreover, a bigger part of our interviewees estimates that an innovator's reputation has significant impacts on idea diffusion. In order to be successful, it is crucial that the idea is visible and compelling for the influential innovators. One of the IdeaBoard members even stated that being well connected is almost as important as having good ideas.

The various tools that are used at BITS to collaboratively develop and discuss ideas seem to play an important role. Confluence is often used as open space where ideas can

be presented and discussed. As the start page of this corporate-wide collaboration tool comprises an activity stream, it commonly catalyzes the diffusion of emergent ideas by depicting to which sections influential members contribute frequently. Our interviewees often describe Confluence as an "idea board" where many evolving ideas are set in motion.

Furthermore, several interviewees state that it takes a considerable amount of training to be really innovative at BITS. As a lot of specialized knowledge about the numerous systems and subsystems exists only implicitly within the heads of few established innovators, the promotion of emergent ideas depends crucially on the support of these people: "You may know all technologies, but as long as you don't know the BITS world, you don't know how to use them", one Software Engineer states. At BITS, this property is especially amplified by the circumstance that there are several divisions like AI competing for their innovations to find their way into the central CBS. In the second round of interviews, we consulted innovators from the PE department, including experts from a specialized task force who are currently working on an online banking suite for the CBS. The ongoing innovation partnerships there are promising sources for further interesting findings. Prototypes are collaboratively developed with external companies and banking personnel, such as an iPad app for wealth advisory. In this context, it is particularly promising to study how ideas can be successfully communicated from BITS developers to customers. For example, one Lead Developer states that one major challenge is to convince the upper management of an idea's benefit for the customer: "*Our problem is that our users are not the ones who buy the product. There's a banker in between, and that banker is often rather a problem than an aid.*"

5.5 Discussion

At the time of writing, we have just finished compiling the BITS dataset. While we were processing the transcribed interviews, we also started to categorize the identified innovation projects and allocated the collected artifacts to them. For example, the many innovation partnerships that currently circulate around the recently established online banking suite each form a separate category. For each of these categories, we construct the network from the involved persons and extract the relevant artifacts as described in the Research Design section. However, our so far presented findings result from

qualitative data analysis and will have to be complemented by the quantitative examination described in this paper.

Interestingly enough, our current findings suggest that peer influence and preferential attachment play a central role in the diffusion of ideas throughout the innovator networks at BITS. Many potentially valuable ideas may be shut down if they are not properly packaged and communicated, but once that two or three influential innovators advocate the idea, it quickly becomes a self-selling item, as the aforementioned interview statements suggest. This circumstance also seems to affirm our assumption that peer influence contributes a lot to exceeding the percolation threshold in innovator networks.

In this regard, we concur with Vitanov and Ausloos (2012), who state that some stages of idea diffusion can be described by epidemic models. More specifically, we contend that social contagion and peer influence are appropriate epidemic models to analyze dynamics of idea diffusion in innovator networks from a quantitative perspective. However, these quantitative models alone may most probably not suffice to improve existing conceptualizations of idea diffusion substantially. Instead, qualitative models that draw on existing conceptualizations of innovation diffusion should supplement quantitative models like social contagion and peer influence when patterns of idea diffusion are studied.

Additionally, our current findings seem to indicate that idea diffusion at BITS complies with a centralized hierarchical diffusion pattern, as described by Desouza (2011, pp. 33-43). In this regard, the findings seem to confirm our assumption regarding the compliance with an advocate model of intrapreneurship (cf. section “BITS Dataset”). But then again, the findings regarding the recent establishment of the IdeaBoard do not fit into that picture. This organizational institution would rather indicate compliance with a “producer model” (ibid), where systems for identifying, funding, and harnessing ideas with potential for radical innovation are in place. Additionally, our findings suggest that the traditional role distinction between innovators, early adopters, early majority, late majority and laggards by Rogers (2010) does not suit the complex structure of the underlying innovator networks at BITS. In this regard, we constitute that existing conceptualizations of intrapreneurship and innovation diffusion alone are too static to capture the more dynamic nature of idea diffusion. The topic of idea

diffusion clearly has conceptual and epistemological vagueness that requires a more explorative approach. Hence, a more thorough examination of the actual idea communication practices from an IM and SNA perspective would be substantial. We claim part of our contribution as studying this phenomenon from these two perspectives.

5.6 Intended Contributions and Future Work

Although we might not be able to capture the full extent of viral idea diffusion (which, however, is very hard to capture in general), we contend that our artifact-driven approach places a stronger focus on diffusion patterns than existing conceptualizations based on observational data do. To the best of our knowledge, our research is the first to study the diffusion of emergent innovative ideas throughout the communication channels of a social network of innovators by examining the impact of peer influence on the percolation of idea-related artifacts. We believe this will essentially improve current conceptualizations of idea diffusion patterns and make significant contributions to both IM and SNA research, as it facilitates deducing guidelines on how to optimize organizational configurations in a way that fosters the generation of beneficial innovative ideas from all sides. However, as our current focus is to encourage research on idea diffusion from both IM and SNA perspectives, and to establish an appropriate statistical model, the results of our study with BITS should be seen as a first step towards identifying patterns of idea diffusion rather than a comprehensive study. Once we have fully established the taxonomy of collaboration structures, we will be better able to classify innovator networks in subsequent studies. To obtain more solid results, comparative empirical studies with several companies are necessary. These should examine additional factors such as the role of the organizational configuration (e.g. with which intrapreneurship model does the company comply) or the type of the idea under observation (radical or incremental, respectively strategic, tactical or operational) in order to identify a variety of the presumably manifold patterns of idea diffusion.

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6 Idea Hubs as Nexus of Collective Creativity in Digital Innovation

(CONFERENCE PAPER)

Raffaele Fabio Ciriello and Alexander Richter
University of Zurich, Binzmühlestrasse 14, 8050 Zürich, Switzerland
ciriello@ifi.uzh.ch
arichter@ifi.uzh.ch

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Abstract: Digital innovation radically transforms the nature of corporate innovation practices, implying a growing need for deeper understanding its origins and outcomes. In this paper, we conceptualize the focal points of social networking in digital innovation as idea hubs. We focus our analysis on instances of idea hubs in two multinational European software companies, where we conducted a case study over a two-year period, and collected data in form of interviews, digital documents, and participant observations. In doing so, we identify a set of social networking practices in which idea hubs serve as nexus of collective creativity and subject these to a critical dialectical examination. We discuss three influencing factors of idea hub choice, namely material infrastructure, innovation process phase, and personal characteristics. These explain why in a corporate environment, despite a variety of digital artifacts individuals can choose from, offline interaction still plays a major role in facilitating digital innovation.

Keywords: Idea Hub, Collective Creativity, Digital Innovation, IS Development, Social Networking

6.1 Motivation and Research Goal

Digital innovation currently attracts growing attention in information systems (IS) research. Having major and, at times, unforeseen impacts on individuals, organizations, and economies, a deep understanding of the origins and outcomes of digital innovation is crucial for academic research and industrial practice. In today's corporate environment, innovation processes have become more open and collaborative in nature, with IT as decisive enabler of networked innovation involving distributed stakeholders (Chesbrough, 2003; Sawhney and Nambisan, 2007). Despite the recently growing number of studies (see Yoo et al., 2012 for an overview), the IS discipline is still far away from having a consistent body of theory to explain important phenomena related to digital innovation, as recent calls and special issues in leading IS journals reflect (Fichman et al., 2014; Nambisan et al., 2014; Yoo et al., 2012, 2010). Particularly the practice of developing digital innovation and the role of digital technologies and human behavior therein remain important topics for IS research (Nambisan, 2003; Nambisan et al., 2014).

However, although the importance of understanding digital innovation in a business context continues to rise (Yoo et al., 2010), few studies have taken a systematic approach towards understanding how firms actually practice digital innovation. As a result, there is still an important gap in our understanding of managing digital innovation in organizations. We know yet little about the problem class of enabling digital innovation practices in a corporate environment and how to create facilitating conditions therefor.

The goal of this paper is to understand the role of social networking in digital innovation practices. Our analysis is grounded on extensive fieldwork we conducted onsite in two multinational European software enterprises. Over a period of two years, one author was able to study practices related to the development of innovative software products and obtained a deep practical understanding of the problem at hand. From this relationship, the need to address digital innovation practices from a social networking perspective emerged in order to better understand the constantly changing way companies innovate with and toward digital technologies. We zoomed in on the focal points of social networking at the case companies through a qualitative examination of semi-structured interviews we conducted with 95 experienced

innovators, 480 digital documents we collected from online platforms, and in total 181 days of participant observations. In doing so, we offer rich insights into digital innovation practices at these companies. By building on a model of collective creativity (proposed by Hargadon and Bechky, 2006), we are able explain how the nexus of creative problem solving lies within interactions between individuals who choose between a variety of online and offline spaces to exchange ideas. We term these focal points of social networking in digital innovation practices 'idea hubs' and, more specifically, address the guiding research questions: *What role do idea hubs play in digital innovation practices?* And: *What factors influence individuals' choice of idea hubs?*

Our contribution is threefold. Firstly, this paper contributes to the emerging literature on digital innovation by deepening our understanding of digital innovation practices. For this purpose, we analyze and conceptualize two software companies' focal points of social networking as idea hubs and focus our analysis on concrete instances of idea hubs as nexus of collective creativity. In doing so, we identify a set of idea hubs. Secondly, weaving the innovation practices in which the idea hubs are embedded enables us to dialectically examine the appropriateness of idea hubs in different contexts. This dialectical appraisal has practical implications in that it illustrates the selection decisions made by different stakeholders who engage in collective creativity. It also has theoretical implications in that it provides a state of the art analysis of social networking in digital innovation. Thirdly, we distinguish three influencing factors on which the choice of idea hubs therein depends, namely 1) the material infrastructure that surrounds the idea hub, 2) the innovation process phase in which employees use the idea hub, and 3) personal characteristics of the individuals that are connected through the idea hub. We discuss that these three influencing factors help to explain why in a corporate environment, despite a variety of digital artifacts innovators can choose from, offline interaction still plays a major role in facilitating digital innovation.

The remainder of this paper is structured as follows. We start by expounding the theoretical foundations of digital innovation and collective creativity. We also conceptualize the term idea hub as a theoretical perspective for studying collective creativity in digital innovation. The research approach section then offers detailed insights into our method and illustrates how we analyzed networking practices in our

empirical study. In the results section, we describe in detail how employees use different kinds of idea hubs as nexus of collective creativity in various ways. We then continue with a discussion of the novel insights and implications our results offer for understanding the nature of digital innovation and for the application of a social networking-based perspective for the analysis of innovation practices. We conclude with summarizing the key takeaways of the study and suggesting areas for future research.

6.2 Related Work

6.2.1 Digital Innovation

Fichman et al. (2014, p. 330) broadly define *digital innovation* as a "product, process, or business model that is perceived as new, requires some significant changes on the part of adopters, and is embodied in or enabled by IT". Digital business model innovation is an IT-enabled, significantly new way of creating and capturing business value, such as Google's sponsored search ads. Digital process innovation is an IT-enabled, significantly new way of doing things in an organizational setting, such as adopting warehouse automation systems. Digital product innovation is an IT-enabled, significantly new product or service, such as ERP/CRM systems, e-book readers, or smartphones. Fichman et al. (2014, p. 344) further argue that the traditional focus of IS research lies on digital process innovation on the part of adopters, and set an agenda for broadening the scope to the development of digital product innovation. Yoo et al. (2010, p. 725) focus more specifically on digital product innovation, which they define as "the carrying out of new combinations of digital and physical components to produce novel products". This implies a focus on the practice (the "carrying out") of digital innovation, and suggests that digital innovation has at least two distinctive characteristics that differentiate the phenomenon from traditional innovation (Fichman et al., 2014; Yoo et al., 2010).

Firstly, digitization of previously analog information is a necessary but not sufficient condition for digital innovation to occur. Characteristics of digital technologies distinctively shape the form of digital innovation. Through this digitalization, products, processes, and business models inherit properties from the digital technologies they

embody, such as increased programmability, malleability, traceability, accessibility, shareability, tailorability, and modularity (Yoo, 2010). In this regard, these unique and distinctive characteristics of digital technologies decisively influence how digital innovation emerges and unfolds (Leonardi, 2011).

Secondly, digital technologies radically transform the nature of established innovation practices on the side of developers and adopters, as they provide an environment of open and flexible affordances that bring forth innovations characterized by convergence and generativity. Here, convergence means that digital innovation brings together previously separate user experiences and industries. Generativity means that digital innovation becomes inherently dynamic and malleable (Yoo et al., 2012). In this regard, digital innovation brings about novel forms of innovating such as combinatorial and distributed innovation. Here, combinatorial innovation refers to how, through recombination of digital artifacts, new products and services with embedded digital capabilities can emerge. Distributed innovation refers to how, due to lower cost of communication and coordination, the innovation practices disperse geographically and move towards the periphery of organizations (Yoo et al., 2012). Accordingly, adopting digital innovation has considerable consequences such as modularity, high switching cost, network effects, Moore's law, and the digitalization of processes (Fichman et al., 2014).

Taken together, these two aspects put forward that the concept of digital innovation constitutes a good starting point for answering a core question in IS research and education, namely how IT transforms business and society (Dhar and Sundararajan, 2007). This arguably provides an answer to why it matters to study digital innovation and the process of its development (Fichman et al., 2014). However, with few exceptions (see Hylving et al., 2012 for an example from the automobile industry), previous research has not addressed the transformational effects of injecting digital technologies into established innovation practices. Hence we agree with Fichman et al. (2014) that we currently enter a 'golden age' of digital innovation, and IS research should now to seize the opportunity of integrating the perspectives of digital innovation and innovation management into one comprehensive approach.

With this study, we contribute to that discourse by taking a practice perspective on digital innovation. A practice perspective facilitates focusing on the work and

behavioral intentions of innovating persons, and foregrounds their actual practices (Majchrzak et al., 2012). The underlying assumption is that innovation is not a one-off moment without a history or future, but rather a continuous, ongoing, and collective accomplishment of something people do and enact (Pantzar and Shove, 2010). *Practices* can be defined as "embodied, materially mediated arrays of human activity centrally organized around shared practical understandings" (Schatzki, 2001, p. 2). As a developer or adopter of a given digital technology-based innovation, a person is a carrier of a social practice. In turn, digital technology itself exists only as technology-in-use, embodied in a specific practice. Accordingly, any innovation process, whether digital or not, can only unfold as a sequence of various practices. The appropriate level of analysis to capture the complexity of digitally networked innovation is, therefore, at the level of social practice (cf. Tuomi, 2002, p. 19).

Outside the IS realm, which only recently began to elaborate a body of literature on digital innovation, scholars from the technology and innovation management discipline have brought forth numerous contributions that could benefit from theorizing about digital innovation, too (Yoo, 2013). For instance, the concept of open innovation suggests that self-organizing networks of employees are a crucial driver for the development of complex and innovative digital technologies (Chesbrough, 2003). In an increasingly networked corporate environment (Von Hippel, 2005), a differentiation strategy based on product, process, or business model innovation can be a key source of competitive advantage (Tidd and Bessant, 2011). According to the open innovation paradigm, companies should purposefully use both inflows and outflows of knowledge to accelerate internal innovation and expand the market for external innovation (Chesbrough et al. 2005). Open innovation leads to a decentralization, where companies replace R&D-based with more network-based work structures (Desouza 2011, p. 8-14). Since traditional R&D departments would only enable selected experienced employees to work on ideas with a long-term impact, ever more companies facilitate collecting ideas from all sides (Neyer et al., 2009). Against this backdrop, idea-driven organizations emerge as increasingly important phenomenon (Robinson and Schroeder, 2014), with companies like Apple or Google providing prominent examples of an entirely novel self-understanding of the employee. Today's leading innovative companies are habitats of so-called *intrapreneurs*, i.e. employees who share the drive

and zeal of entrepreneurs, but innovate within the confines of their organization, relying on its technical, financial, and professional resources (Desouza, 2011). For instance, Desouza (2011) conceptualizes the employee-driven innovation process as a circular process that starts with the *Idea Generation & Mobilization* stage, where novel ideas are brainstormed and set in motion, before they become discussable projects competing for funding in *the Advocating & Screening* stage. The funnel gradually narrows down in the *Experimentation* stage where innovators explore solution possibilities and constrain the possible solution stage, before turning the idea from concept to solution and developing a marketing plan in the *Commercialization* stage. Eventually, in the *Diffusion and Implementation* stage the company seeks to push the idea to the farthest corners of the market and show customers how to use the new product or service successfully.

These perspectives have in common that they put the networked innovator into the center of attention, a tradition that dates back to the very roots of research on innovation. In the pioneering works of Schumpeter (1934), on which many digital innovation scholars also rely on, the concept of innovation is tightly intertwined with the person of the *entrepreneur* as a central (and sometimes only) carrier of economic growth and creative disruption. However, Schumpeter lived at a time when industrial processes followed standardized and repetitive patterns, where employees worked off predefined task lists, and innovation was rather an exception than a rule. Nowadays, shrinking innovation cycles and new digital technologies make innovation more constant, networked, and employee-driven (Chesbrough, 2003; Desouza, 2011). In addition, embracing the distinctive characteristics of digital (as opposed to non-digital) innovation gains in importance, since these characteristics also influence the tools that are used and vice versa. Assumptions about stable industries and fixed products would limit the potential of digital technology (Yoo et al. 2012), and we are only at the beginning of understanding the complex interrelations between digital innovation and the practices of digitally networked persons.

6.2.2 Collective Creativity

The so far presented literature suggests that the concept of digital innovation has the potential to radically renew traditional assumptions and beliefs about innovation.

Existing literature on innovation focuses either on characteristics of the individual, on characteristics of the enabling technology, or on the process of innovation. Whereas these perspectives provide helpful starting points exploring innovation processes at the aggregated level of organizations, it has shortcomings regarding the previously described bottom-up emerging, multifaceted, and often serendipitous nature of digital innovation (Andersen, 2008; Hargadon and Bechky, 2006, p. 485). Employee-driven innovation requires a stronger focus on work practices and depends on a variety of influencing factors that are not yet fully understood.

At the heart of each innovation lies an *idea*. Ideas can originate from problem-solving engagements or at random moments; they differ in their scope (e.g. operational, tactical, strategic) the degree of change they impose (e.g. radical or incremental) and their orientation (e.g. internal or external) (Desouza 2011, p. 25-33). Initially, ideas exist only as an abstract conception in someone's mental model, i.e. an intangible and volatile image in the mind of a person (Partridge 1991, pp. 303-304). Only when a person communicates an idea, it meets the realm of reality and becomes a germ cell of innovation. If we want to understand digital innovation, we therefore need to understand how involved stakeholders construct and negotiate ideas in social interaction. One person's practices (such as providing feedback or giving help) shape the practices of another, which then in turn shapes the practices of others. This collaborative aspect of idea development can be explained with *collective creativity*, which is based on the notion that creativity in organizations occurs as a confluence of ideas from multiple sources (Hargadon and Bechky, 2006, p. 486). It puts forward that that creative ideas often do not stem solely from 'eureka' moments of individual cognition, but rather from insights that emerge in interactions between individuals, such as collaborative problem solving. Collective creativity can be an opportunity for organizations to generate creative ideas when people from various domains come together to find, redefine, and solve problems that no one could have done easily alone (Hargadon and Bechky, 2006). But it can also be a challenge because creative ideas encounter many barriers in organizations, such as resistance from established institutions (Hargadon and Douglas, 2001). Companies that facilitate collective creativity put great effort in creating an environment where employees are willing and able to engage in innovative problem solving (Hill et al., 2014). Prominent examples are

the Google's offices with many playful components and relaxation areas (Brown, 2008) and the big atrium in Pixar's central office (Rao et al., 2008). The architecture of the building simply does not allow employees to finish their working day without running into their co-workers, thereby fostering collaboration and facilitating the flow of ideas across organizational units.

These studies imply a strong focus on the way employees connect and network. Social networks play a crucial role in nearly all aspects of organizational life (Agarwal et al., 2008), and as such are also an important part of digital innovation practices. Recent studies consider those innovators as capable who are well connected and collaborate with their personal network of innovators, champions, and gatekeepers (Graf and Krüger 2011, Desouza 2011, p. 72). Fichter (2009) links research on open innovation more closely to the networking practices of innovating persons, who he terms champions and promotors. Based on promotor theory, i.e. the notion that innovation outcomes depend on specific persons (promotors) who help overcoming certain barriers (Hauschildt and Kirchmann, 2001), he introduces the notion of *innovation communities*, which he defines as "an informal network of likeminded individuals, acting as universal or specialized promotors […] that team up in a project related fashion, and commonly promote a specific innovation" (Fichter, 2009, p. 360). Innovation communities can be differentiated from scientific or R&D communities by their declared goal to promote a specific innovation project. Collective creativity always revolves around a specific idea. In this regard, collective creativity can be seen as the central practice that is carried out by innovation communities.

6.2.3 Idea Hubs as Nexus of Collective Creativity

The so far presented literature suggests that collective creativity is a central phenomenon in digital innovation, and as such could provide a good starting point for developing its body of theory. In research practice, however, a series of obstacles makes it very difficult to observe collective creativity. Firstly, the ephemeral and punctuate occurrences of collective creativity make it difficult to judge whether a particular interaction between individuals later led to the creative insight that sparked the innovative idea (Hargadon and Bechky, 2006). Secondly, getting deep insights into how social interactions generate team level creative synergy requires ethnographic methods

with high involvement of the researcher (Wickson et al., 2006). Thirdly, the dynamic and constantly changing environment within which employees engage in collective creativity occurs requires suitable a theoretical perspective that is lacking so far (Fichter, 2009). For this purpose, our contribution proposes the *idea hub* as a novel perspective to study this multifaceted and complex phenomenon. We define an idea hub as a nexus of collective creativity, where different kinds of employees collectively generate, refine, or extend innovation-ideas online or offline. The word *nexus* itself originates from Latin and means 1) a connected group or series, and 2) a central or focal point. An idea hub as nexus of collective creativity is the focal point where a connected group of employees bind ideas together to generate team level creative synergies.

6.3 Research Method and Empirical Context

This section details our research approach. Since our motivation was to understand social networking practices in the context of digital innovation from a participant's perspective, we conducted an interpretive case study (Walsham, 2006, 1995) of innovation practices at two multinational European software companies. In framing the study, we took an interpretive epistemological and ontological stance, in which facts and values are intertwined ingredients of scientific knowledge, and 'reality-for-us' is an inter-subjective social construction of the shared human cognitive apparatus (Walsham, 1995, p. 76). As typical for interpretive research, we used an iterative approach to data collection and analysis until a coherent picture emerged, moving back and forth between theories and the different interpretations of the case study material we obtained from social constructions such as language, shared meaning, documents, tools, and other artifacts (Klein and Myers, 1999). Over the course of two years, our approach was to zoom in and out iteratively (Nicolini, 2009) on the innovation practices at the case firms, beginning as an in-depth study in one location and then expanding to another location by following emerging relations, while switching between multiple theoretical lenses when interpreting them (Walsham, 2006).

6.3.1 Case Selection

Since the above described previous research suggests that practices are especially relevant in innovation processes that are that are employee-driven (Desouza, 2011), involve the confluence of ideas from various sources (Chesbrough 2003), and deal with specific characteristics of digital technologies (Yoo et al. 2010), we selected the cases based on three criteria: 1) high activity of employee-driven innovation 2) high degree of collaboration and 3) high involvement of digital technologies in the development and outcome of the innovation. This lead us to turn to the following two multinational European software companies

Banking and IT Solutions (BITS): Founded in the early 1990ies by a group of software engineers, the company rapidly grew to an international market leader in banking software. Until 2008's financial crisis increased the pressure to innovate and diversify its solution portfolio, the strategic focus of BITS was the development, distribution, and operation of its proprietary core banking system. The executive board became increasingly concerned that the product lifecycle of that system might have peaked, and initiated substantial investments in establishing an internal innovation management framework. In the following years, the strategic focus of BITS became the development of new products, services, and business models in collaboration with customers, external partners, and universities. In the last two years, the company grew from around 600 to more than 1400 employees in two development centers and seven subsidiaries worldwide. It is therefore an appropriate subject for examining collective creativity in digital innovation.

Custom Software Engineering House (CustomSoft): An engineering startup founded 1996 as a side project from a group of computer science PhD students. Quite different from BITS, the core business of CustomSoft is to develop large software applications on client order. Customer segments include transport, health, and space agencies, as well as public administration, banks, and insurances. In addition to software development, the around 350 employees offer complementary services such as technical consulting, project management, and requirements engineering. In order to reduce the financial risk that results from the company's high dependence on client orders, the management board constantly seeks to better use the potential of the highly specialized domain

knowledge their employees obtain at the customer side. More recently, executives declared it the company's strategy to improve their innovation practices. CustomSoft is therefore an appropriate subject for validating, extending, and refining the company specific findings of the BITS study.

Until today, both companies are commercially successful, as they have achieved continuous growth in revenues, staff, customers, users, and international subsidiaries with their self-made software-based products and services. But they also face the same challenge: A generation of innovative founders who, decades after successfully launching, developing, and nurturing a business, want to hand over power and control to future generations in a way that the company's innovative capacity can be sustainably preserved. For this, they both put emphasis on selective recruiting of university graduates and creating conditions in which employees can realize their creative potential. In both companies, work is largely structured around generating novel solutions to novel problems.

6.3.2 Data Collection

Our data collection followed the principle of triangulation (Silverman, 2006, p. 291) where we examined the research issue from different sides, compiling multiple interpretations obtained from interviews, observations, field notes, and documentary material into a coherent picture (Klein and Myers 1999). One author engaged in the organizations as involved researcher and collected a considerable amount of data through interviews, online and offline observations, field notes, and collecting documentary data. Over the course of two years, the data collection unfolded as described in the following phases.

In the first phase (02/2013 – 10/2013), *identifying key themes*, the study focused on the way employees communicate ideas across intersecting social worlds. We studied in detail the co-located networking behavior of 32 experts from the BITS headquarters in Switzerland. The first author spent between 2-4 days a week onsite at the BITS headquarter and had access to an in-house workstation and intranet platforms. From there, the author conducted interviews to get an in-depth understanding of the focal phenomenon from a participant's perspective (Miles and Huberman, 1994). In addition,

the author attended formal gatherings (meetings, workshops, presentations and fairs), as well as informal gatherings (lunches, impromptu meetings). Executives helped us with identifying an initial set of interview partners. From there, we proceeded with snowball sampling, through the network of personal contacts (Stebbins, 2001). Questions addressed the participants' innovation practices when collaboratively developing ideas, whereat participants were required to use authentic examples of their own experience. In doing so, we identified a series of gatherings where participants connect and network to exchange ideas. A series of participant observations at the identified gatherings followed and, where possible, photographs and field reports complemented the observations. In addition, we systematically analyzed the collected digital documents to identify key themes. This allowed us to make sense of the observed and described situations, and to formulate more specific themes to feed future studies. The first phase ended with writing an interim study report with a status quo analysis, which we presented and discussed with BITS representatives to inform about our findings and frame the next phase.

In the second phase (01/2014 – 12/2014), *validating, extending, and refining constructs*, the study focused in parallel on how BITS and CustomSoft employees collaborate across geographically distributed locations. Platform observation alleviated tracking acts of online networking. The first author continued to spend between 1-2 days a week onsite at the BITS headquarter, and additionally spent between 1-2 weeks in a row onsite at various remote subsidiaries of BITS and CustomSoft respectively, during which he interviewed 30 BITS and 33 CustomSoft experts from subsidiaries in the UK, Macedonia, Singapore, Philippines, France, Luxembourg, and Liechtenstein. Questions addressed the way employees organize and share information about their innovative ideas. We thoroughly analyzed online networking platforms such as Confluence regarding their actual and potential usage for innovation and elaborated a set of key use cases. We observed these online networking platforms and extracted documents related to the innovative projects we identified in the interviews. By triangulating between 1) the primary data from the interviews, and 2) the collected secondary data we extracted from these platforms, we were able to draw a more detailed picture of the actual innovation practices. Thus, we claim part of our contribution as providing an example for analyzing innovation practices. The second phase ended with writing two reports

with a catalogue of measures and solution concepts that were presented and discussed with BITS and CustomSoft representatives to identify concrete actions to take in the next phase.

In the third and ongoing phase (from 01/2015), *generating impact through embedded research,* the first author cooperates with BITS project teams on both planning and engineering tasks to simultaneously document the practitioners' practices in detail and transfer the obtained scientific understanding into practice. The analysis in this paper draws exclusively on the collected data from the first two phases, but for the sake of completeness, we mention that the ongoing collaboration with the industry partner also provides us with an opportunity to collect feedback for our emerging claims (Walsham, 2006).

Table 6-1 : Overview of Collected Data

Data Source	1st Phase (02/2013–10/2013)	2nd Phase (01/2014–12/2014)	Total
Interviews	32 with BITS	30 with BITS 33 with CustomSoft	95 Interviews - Total=5677min (Average=59.76, min=19, max=104)
Documents	216 from BITS	264 from BITS 62 from CustomSoft	480 documents - E.g. project documents, wiki pages, online platform content, archival data
Participant Observation	113 days onsite at BITS	50 days onsite at BITS 18 days onsite at CustomSoft	181 days spent onsite the case companies - Attending formal project meetings, workshops, presentations, and maintaining informal contacts - Giving talks, organizing workshops and steering meetings, collaborating with project teams

Throughout the whole study, the first author of this paper was the primary responsible of collecting data and writing interim reports episodically, keeping a consistent perspective on the research issue as the academic-industry collaboration evolved. In all,

the author conducted 95 semi-structured interviews with experts involved in the innovation practices at BITS and CustomSoft. In addition, we collected in total 480 digital documents from online platforms such as intranet wikis or social media platforms, and conducted a series of participant observations. Using these multiple sources of evidence facilitated drawing a richer picture of innovation practices, hence shedding more light on what innovators actually do through participant observations and document analyses, rather than learning only from what they say they do through interviews.

6.3.3 Data Analysis and Interpretation

In analyzing the case data, we applied the principle of the hermeneutic circle, which suggests "we come to understand a complex whole from preconceptions about the meanings of its parts and their interrelationships" (Klein and Myers 1999, p.71). As typical for interpretive research, we inductively generated shared meaning from the collected data through qualitative data analyses and interactions between authors and between authors and informants from practice (Walsham 1995, 2006).

We carried out the data analysis collaboratively relying mostly on interview transcripts, collected documentary material, and field reports. Nearly all interviews were audio recorded, transcribed, and processed using a coding scheme developed and continuously refined in MAXQDA. Two out of 95 interview partners refused to audiotape the interview. In these two cases, we coded our written interview notes. 61 Interviews were in German and we translated the quotations. The remaining 34 interviews were in English. 86 interviews were face-to-face, 8 interviews were online using video conferencing, and 1 interview was over the phone. We met in a group of four researchers in weekly focus groups (Krueger, 2009) to maintain a critical distance of the embedded researcher with the case company (Wickson et al., 2006), moving back and forth between data and theories, interrogating field material to check whether the data supported emerging claims, conversely, whether theories helped us making sense of the empirics (Yanow and Schwartz-Shea, 2013). The interviews were recorded and transcribed following a denaturalized approach, which focuses on meanings rather than on accents of the interviewees (Weston et al., 2001). We crosschecked the transcriptions

among the research team to increase internal validity, and analyzed the cases for discrepant evidence (Weston et al. 2001). The transcriptions were imported into MAXQDA to facilitate joint analysis and increase confidence in the findings, where two researchers developed a codebook (DeCuir-Gunby et al., 2011). Two additional researchers carried out coding checks to ensure intercoder reliability and develop a shared conception of reflection (Weston et al., 2001). We further elaborated the codebook in weekly focus groups to identify themes from various interviews and derive new codes in vivo from the data (DeCuir-Gunby et al., 2011). Basic coding dimensions included 1) the setting in which employees use idea hubs (e.g. meetings) 2) involved actors 3) the form of the idea hub (e.g. online or offline) 4) the interviewees judgment of the idea hub's suitability for collective creativity and 5) tools used in the idea hub (such as video conferencing). The coded units were phrases, sentences, or paragraphs (Weber, 1990).

In addition, we provided the case companies with continuous with feedback and opportunities to reflect on their own practice (Walsham, 2006). Having key informants from the companies review our in total four interim study reports enabled them to reflect on our findings and report any discrepancies with their interpretations. We discussed the emerging findings of the study in intensive workshops and presented them at company-internal talks to help practitioners reflect on and improve their own practices.

6.4 Results

Table 6-2 : Overview of Identified Idea Hubs

Type	Description	
Offline Idea Hub (Collectively creating ideas in co-located formal and informal meetings)	Informal	Spontaneous impromptu gatherings and purposeful casual appointments to discuss early ideas, get feedback, and cultivate social contacts. E.g. coffee breaks, lunches, informal talks.
	Formal	Workshops, presentations, fairs, and contests to persuade potential stakeholders and decide on next steps.
Online Idea Hub (Collectively creating ideas synchronously or asynchronously using collaboration software)	Synchronous	Facilitates idea-related information sharing to merge idea-related information supply and demand.
	Asynchronous	Facilitates time-delayed knowledge work to coordinate meetings, prepare reading material, share meeting minutes, share idea content and collaborate on shared documents.

This section illustrates the idea hubs in the innovation practices at BITS and CustomSoft, and table 2 provides an overview. We structure our analysis into *offline idea hubs*, where employees collectively create ideas in co-located formal and informal meetings, and *online idea hubs*, where geographically distributed employees collectively create ideas using collaboration software in a synchronous or asynchronous way. In this regard, our study provides not only insights into employees' online networking practices (e.g. with social media), but also into the offline networking practices, as well as the intersection between the two. These different kinds of idea hubs are an important factor in supporting the social networking practices of innovative employees.

6.4.1 Offline Idea Hubs

An offline idea hub is a nexus where co-located employees meet in a formal or informal way to collectively create ideas. Formal hubs are conventional, planned, and rehearsed meetings, with ideas being carefully selected and pronounced. In contrast, informal hubs are unconventional, unplanned, and unrehearsed meetings, with ideas developing freely as the discussion evolves.

Informal hubs in innovation practices at BITS and CustomSoft include spontaneous impromptu gatherings and purposeful casual appointments. These are mainly important to informally discuss early ideas and get feedback, but also to make new connections and maintain existing ones. Most employees emphasized the importance of informal meetings for nurturing their social capital, and we observed that different kinds of office arrangements lead to different networking practices. For instance, at BITS' multilevel headquarter offices in Switzerland, employees typically communicate early ideas informally at the coffee corners. Each office store has at least one of these designated open spaces. They feature many playful and casual elements such as video game consoles, beanbags, couches, books, magazines, and whiteboards, as well as free food and beverage dispensers. Here, employees commonly share ideas when doing stand-up meetings, simply running into each other, or using these facilities for 'Apéros', a common Swiss habit of sharing a drink and snacks before dinner. One employee stated "*you always find some time to occasionally discuss ideas over a coffee or at lunch*" [i10, Middle Manager, BITS CH]. Another agrees, "*We discuss ideas over a coffee very often. Really, coffee is extremely important*" [i42, Consultant, BITS CH]. In turn, at BITS' open plain offices in the UK, informal meetings often start as gatherings of two or three people discussing an issue, then attracting further interested employees to join the discussion and share their ideas. One employee stated:

> *"We are open plain here. Everyone can see each other. There is a bit more of a less formal environment about it. In Switzerland, you poke your head around in someone's room whereas here, you just walk over to their desk."* [i50, Middle Manager, BITS UK].

At CustomSoft's Swiss headquarter, where open plain offices are spread across different facilities, employees often share ideas when running into each other between buildings, if they feel they are in a trusted environment:

"I have some peers where I can place my ideas without any risk. That's usually over a coffee, when walking over to the canteen, or at the tabletop soccer. […] They are good listeners but also busy people, so they do not push me all the time. […] But there are also people who I call the preventers of everything. And with these preventers I am careful with even mentioning the idea, because they often not only have the potential to choke off the idea, but also to choke off my motivation" [i85, Software Engineer, CustomSoft CH].

In addition, many employees at both companies arrange recurring or occasional casual appointments such as breakfast meetings, brown bag lunches, or 'tech talks' with internal or invited speakers presenting recent topics. Most employees perceive such events as fruitful sources for ideas, as one employee describes:

"I often network after a tech talk or at a [breakfast] meeting, when I run into someone […] and say 'hey, what did you think about that?' Then you have a little bit of open discussion, and they say 'yeah, we had another idea there'" [i34, Project Manager, BITS CH].

Formal hubs in innovation practices at BITS and CustomSoft include workshops, presentations, fairs, and contests. These are mostly important to persuade potential stakeholders and decide on next steps. For instance, both BITS and CustomSoft have designated 'innovation board' committees of selected experienced employees from various organizational units. These committees organize regular audition meetings where proactive employees can present ideas, get reviews with suggestions on next steps, build social coalitions with collaborators and influential advocates, and possibly obtain funding. In both companies, the innovation board purposefully organizes various events to foster employee-driven innovation. For instance, the BITS innovation board organizes a yearly 'idea fair' where employees are asked upfront to submit a filled in factsheet to a call for ideas. After an initial screening, the innovation board invites authors of the eight most promising ideas to create a poster presentation. The CEO and various executives then inaugurate the idea fair with a keynote, followed by employees walking around the various poster booths, where authors present the ideas. Afterwards, employees vote for ideas and the innovation board audits the most voted ones for further funding. The CustomSoft innovation board also organizes contests where students compete with ideas for prizes: "*We have two online rounds and one on-site round, where 32 finalists are competing for nice prizes like a trip to Jazoon with all expenses covered.*" [i70, Senior Manager, CustomSoft]. In addition, the innovation boards also

maintain internal online idea platforms, which we describe in detail in the following section. Employees perceive these innovation boards in quite different ways. Some appreciate the possibility to bring in ideas and see the innovation board as facilitator, catalyst, and network expander. Others criticize the innovation boards' lack of decision authority and structured processes to realize an idea and see them rather as unnecessary gatekeeper and pre-filter of the executive board

> *"There is one easier way, namely you need a customer. If a customer funds your idea, you bypass many things. [Otherwise] it happens that the innovation board approves and then the executive board rejects it."* [i10, Middle Manager, BITS CH].

In this regard, the innovation boards seem to be caught in between top-down and bottom-up innovation. In addition, many employees attend academic and practitioner conferences such as the International Conference on Software Engineering (ICSE), the German Wirtschaftsinformatik conference (WI), Jazoon, or Java User Groups (JUGs):

> *"I like conferences because they are good for meeting new people and topics. People who present at a conference usually have more fire for a topic. I also give talks myself, and that is even better for networking. People approach you who are actually interested."* [i93, Senior Manager, CustomSoft CH].

Some groups of employees also organize different kinds of retreats where they gather for a weekend in remote locations such as alpine huts to discuss recent innovative social, economic, or technical developments at so-called symposia, or to collectively tinker and experiment with novel technologies at so-called code camps.

6.4.2 Online Idea Hubs

An online idea hub is a nexus where distributed employees collaborate using IT artifacts to collectively create ideas in a synchronous or asynchronous way. Synchronous hubs are settings in which employees collaborate using online media simultaneously. Asynchronous hubs are settings in which employees use online media to work time-delayed with each other. Both synchronous and asynchronous hubs are important for exchanging and producing idea-related information.

Synchronous hubs in innovation practices at BITS and CustomSoft facilitate idea-related information sharing with social media, office web applications, and

telecommunications software for instant messaging, (video) calls, and file exchange. These are mainly important to merge idea-related information supply and demand. Employees in both companies frequently use telecommunications software such as Microsoft (MS) Lync, Citrix GoToMeeting, or Jabber.org to ask questions, discuss issues, request feedback, make formal or informal appointments, or create topical chat groups. Emails often serve as a trigger for collaboration, to quickly call for feedback, to ask questions, and send requests: *"When I push information by email, I get more feedback."* [i40, Senior Manager, BITS CH].

Using video conferencing, employees often conduct online meetings to discuss ideas: "*Based here in [the UK], I can't always be travelling. So I communicate a lot over video conferencing with my team in [Switzerland].* [i58, Middle Manager, BITS UK]. However, many employees emphasize that web cams should accompany any online meeting to focus the discussion more and be sure to have the opposite's undivided attention. Especially when communicating ideas, having distracted opposites would be inhibiting, as an employee stated:

> *"[Adding video to calls] takes away some of the temptation for people to go off and do other things. [There are also] special rooms with cameras, dedicated facilities that increase the feeling of working together with people in other locations. You all go into that conference room and then you focus. You're not at the desks, surrounded by papers."* [i44, Senior Manager, BITS UK].

Another employee adds that visual and, whenever possible, face-to-face communication is more appropriate for persuasion:

> "*You normally need face-to-face contact. People think video conferencing, telephone, and emails heal all wounds and lead to the same result in any case. For me, it is much easier to convince people that an idea is cool and that they should engage in it using facial expressions, and not only two dimensional videoconferencing expressions".* [i79, Sales Manager, CustomSoft].

Perhaps this might explain why social media such as Facebook, Twitter, or LinkedIn only play a minor role in innovation practices at BITS and CustomSoft. Though both companies maintain official social media channels for news publishing, event management, and staff recruiting, and few employees occasionally use social media to ask questions about projects they work on, our study found practically no evidence of

using social media as a nexus of collective creativity. One employee even states cynically: "*What would I get if my idea got 100 likes? Would I then get the resources to realize the idea? If I got 100.000 franks for 100 likes I would try it maybe*" [i25, Technical Lead, BITS CH].

In addition, many employees collectively and concurrently create ideas using office web applications such as Google Docs or MS Office 365, with browser-based word processors, spreadsheets, presentation software, and note taking tools. One advantage of these is the ease of distributed synchronous collaboration, as one employee stated:

> *"[In my team we] typically start with a whiteboard discussion and afterwards we use Google Docs. We made very positive experiences with [such tools] because many people can contribute simultaneously and notice if something is not usable. I think good ideas evolve more often in collaboration. Someone has a spark and then it gets to a first discussion, and then you must involve the whole team instead of writing a long document which you then send to a review"* [i28, Technical Lead, BITS CH].

The many participant observations we conducted in workshops and meetings at BITS provided further empirical evidence of the use of synchronous hubs. Many employees appreciated the possibility to collaboratively edit wiki pages in meetings, while a beamer displays the page to all attendees.

Asynchronous hubs in innovation practices at BITS and CustomSoft facilitate time-delayed knowledge work with idea wikis, reviewing systems, and issue trackers. At BITS as well as CustomSoft, employees extensively use wikis such as Atlassian Confluence to coordinate meetings, prepare reading material, share meeting minutes, share idea content and collaborate on shared documents. As previously mentioned, both BITS and CustomSoft have innovation boards that maintain designated idea wikis. The CustomSoft idea wiki is an open platform where all employees can submit, view, edit, and comment on ideas. All employees are allowed to use a few working days to initiate an idea site, and blue-sky thinking ideas are explicitly encouraged. The start page features an activity stream, depicting the ideas to which members contribute frequently. In addition, the CustomSoft innovation board uses the idea wiki to track a project's status. As with the innovation boards, employees' opinions about the idea wiki diverge, too. On one hand, this openness has lead to a substantial amount of several hundred submitted ideas and employees appreciate the democratic character of the

platform. This would also contribute to employee motivation and satisfaction: "*our [idea wiki] is an important instrument. When someone posts an idea there, I always try to at least like or comment it. That's an encouragement aspect*" [i93, Senior Manager, CustomSoft CH]. Others criticized a resulting glut of half-baked ideas without a clearly structured realization concept behind. If at all, only those ideas that influential employees submitted would have been realized. Referring to such an idea that has been initiated by an executive board member and then realized, one employee criticized:

"One could say that the idea was simply that much better than others. But I have seen many other good ideas that did not get the same support. I think that was not only because of the idea quality, but also because [he has] the best network of all. Many people respect him a lot." [i85, Software Engineer, CustomSoft CH].

Moreover, allowing all community members to provide feedback has led to several frustrated employees who got negative feedback or even worried that their ideas would be stolen.

Many employees at BITS confirm that the involvement of certain influential individuals has significant impact on the outcome of an idea. Two of the BITS innovation board members even stated that stakeholder management would be as important as having good ideas. This can be both beneficial and detrimental at the same time. Some say, such key persons can give strong support, help overcome barriers, and let others benefit from their experience, as one employee stated:

"There are certainly some key persons up there, […] well-established opinion leaders, who must carry an idea or it has little chances. But that's actually normal and okay. Ultimately, these are the really good people, the seniors, who are able to turn some foolish thought into a concrete, good idea." [i1, Software Engineer, BITS CH]

Others rather criticize that certain key persons can be big barriers themselves. Referring to two such key persons within the company, one employee states:

"I do like [S.] and [J.] a lot, and one must say they are extremely intelligent and competent; they have achievements that others would not have achieved in a thousand years. But these are exactly the people who are extremely hostile to an innovation if it was not their own idea." [i24, Partner, BITS].

In contrast to CustomSoft's open idea wiki, the BITS idea wiki is a rather closed platform where innovation board members only publish information about those

selected ideas that have been presented at the idea fair, and ideas typically relate to a previously predefined area of the company's strategy. An idea wiki page contains a 5-minute video presentation, the poster, additional information in text, and a comment function. The idea wiki manager stated:

> *"We realized we should give people a platform where they can collect the ideas that float around in this company, so they can generate ideas on a broad base and build coalitions […] and not only the people 'up there'"* [i32, Manager, BITS CH].

Still, some sharp tongues criticized that the accepted ideas were only those that incrementally contributed to the strategic areas the executive board previously defined. In short, the idea wikis seem to reflect on the innovation boards' top-down/bottom-up dilemma.

Issue trackers are a further, perhaps rather unintentional, asynchronous idea hub at BITS and CustomSoft. Originally, issue trackers are intended to manage the reception, affirmation, processing and documentation of customer and/or internal tickets like change-, support-, or functional requests, and trouble reports. However, many employees have appropriated these tools so extensively in their daily work practices that they often misuse them as online idea hub. Because users can subscribe to issues and get notifications when something changes, employees often use this daily work tool for tracking and anchoring idea-related discussions. One employee stated:

> *"An issue tracker is good for when you first have an idea [because] you always have a central point of communication. Whenever you email someone, you can start your email with a link to the issue. It is a good place for storing the different versions of the artifacts in there, as well."* [i60, Software Engineer, BITS UK].

At selected units in BITS, employees can use ten percent of their working time to create issue tracker tickets for their idea and implement them. These tickets are then checked and prioritized by a manager, who stated: *"The idea is to enable incremental product innovation"* [i6, Technical Lead, BITS CH].

6.5 Discussion

In the previous section, we provided rich insights into digital innovation practices at the two multinational software providers BITS and CustomSoft. We can confirm that in the dynamic and constantly changing software industry, innovation is increasingly characterized by network-based work structures (cf. Chesbrough, 2003; Desouza, 2011; Von Hippel, 2005). This requires people with different backgrounds to work together across organizational boundaries. However, aligning disparate innovation communities with different kinds of specialized knowledge is challenging, particularly when creating novelty (Majchrzak et al., 2012). This paper adds to the body of knowledge on digital innovation in that it identifies specific practices that foreground the bottom-up emergence of ideas that are collectively created in various settings. We structured our analysis of social networking in digital innovation practices at BITS and CustomSoft into online and offline idea hubs. Our results provide an empirical account of individuals' choice of idea hubs in various digital innovation practices, on which we elaborate more explicitly in the following.

6.5.1 Implications for Digital Innovation Research

This section starts with dialectically examining the identified idea hubs' appropriateness in different contexts, and corroborating these insights with theory. We then present and discuss three influencing factors of idea hub choice that emerged as important from our analysis, namely 1) the role of the infrastructure and its material characteristics in which the idea hub is situated, 2) the role of the innovation process phase in which the idea hub is selected, and 3) personal characteristics of the participants that are connected through the idea hub. Table 3 provides an overview of these.

Table 6-3 : Idea Hub Choice and Influencing Factors

Construct	Influencing Factor	Description	Data Source
Idea Hub Choice	Material Infrastructure	Individuals choose idea hubs depending on how infrastructural arrangements allow collective creativity to unfold.	Documents, Interviews
	Innovation Process	Individuals choose idea hubs depending on the necessary formality of interaction, which tends to increase with advancements in the innovation process phase.	Interviews, Participant Observations
	Personal Characteristics	Individuals choose idea hubs depending on the possibility to involve influential promotors (Fichter 2009) or catalysts (Tortoriello et al. 2014).	Interviews, Participant Observations

6.5.1.1 The Dialectics of Idea Hub Choice

Employees can choose from a variety of idea hubs to engage in collective creativity. These idea hubs can be more or less appropriate depending on a variety of factors, as we elaborate in the following critical dialectical examination of the illustrated practices around idea hubs.

As our study shows, employees often use co-located informal idea hubs for establishing and maintaining social connections, for freely generating ideas, and for getting first feedback in a trusted environment. They frequently choose these casual gatherings to get a feeling of whether further persuading an idea could be worthwhile or not, as for instance reflected in the observed practice of discussing ideas in coffee corners. However, while such idea hubs tend to be suitable settings for getting feedback, they tend to be less suitable for making concrete decisions on further steps. When employees feel the idea is ready for invoking more impact, they often turn to more formal gatherings such as board meetings, fairs, or conferences, where they can place

ideas more prominently and possibly obtain needed resources, but also risk getting negative feedback that can ultimately stop the idea. Conflicts can arise when there exist multiple gates within a company, which impose divergent views on the idea, as the tension between the innovation boards and executive boards in both companies reflected. The top-down/bottom-up conflicts that arose in both companies indicate political tensions in employee-driven digital innovation.

Online idea hubs facilitate the confluence of ideas from various locations, and expand the personal network on which the employee can draw. Synchronous online collaboration tends to be more appropriate for quickly producing idea-related outcomes, and can in many situations complement formal or informal offline communication. Some configurations can even lead to high degrees of collective creativity, as employees' appraisal of simultaneous collaboration on documents using office web applications indicates. However, as employees' criticism of online communication reflects, synchronous online communication has more sources of distraction and is therefore often less focused, especially if visual aids such as video conferencing are missing. Because interactions are less rich, it tends to be harder to facilitate the necessary degree of informality that often leads to creative discussions. Many employees complemented co-located interaction in workshops or fairs with distributed interaction for idea generation, coalition building, and fund raising. This observation is consistent with previous propositions that suggest face-to-face communication and co-presence are a must for sharing specialized knowledge, developing mutual trust, and reaching common understanding (Fichter 2009; Gerybadze, 2003, p. 155).

Media choice theories, such as social presence theory and media synchronicity theory, can explain these observations. Social presence theory is based on the notion that individuals make rational media choices based on the allowed degree of social presence, i.e. the possibility to communicate one's personality and non-verbal cues (Short et al., 1976). This notion explains well why many employees complemented co-located with distributed idea hubs when engaging in collective creativity. Given that people tend to make sense of new things based on their existing mental model (Hargadon and Douglas, 2001), communicating ideas requires the sender to persuade the recipient of the novel idea's value, and that can be better achieved in face-to-face communication through its higher degree of social presence. The basic idea behind social presence theory has later

been refined in media synchronicity theory, which is based on the notion that individuals make rational media choices based on the allowed degree of synchronicity, i.e. the degree to which multiple persons can work on the same task simultaneously (Dennis et al., 2008; Dennis and Valacich, 1999). This notion explains well why employees in our study often complemented synchronous idea hubs (such as chat, video conferencing, or office web applications) with asynchronous idea hubs (such as issue trackers, wikis, and social media) for distributed collective creativity.

6.5.1.2 Influencing Factors of Idea Hub Choice

Material Infrastructure: Infrastructural arrangements influence how collective creativity unfolds within idea hubs. For instance, many employees at BITS CH described coffee corners as particularly important sources of collective creativity. Here, people with different roles, different backgrounds, and different views can gather to share and exchange ideas informally. In a similar way, the 17th and 18th century coffee houses are today considered crucial for proliferating the Age of Enlightenment (Johnson, 2010). In turn, open plain offices are often a stage for contagious discussions. At times, slightly different configurations of spatial arrangements can lead to significantly different outcomes. For instance, the different configurations of the BITS idea wiki and the CustomSoft idea wiki led to different manifestations of collective creativity. The varying degrees of platform openness had an influence on the quantity, scope, and outcome of submitted ideas. At CustomSoft, everybody could contribute to the idea wiki and governance structures were flat. This led to more democratized innovation and blue-sky ideas, but also to a lack of structured processes, which ultimately resulted in a situation where those ideas that influential individuals carried had a better realization chance. At BITS, only selected employees centrally managed the idea wiki and governance structures were hierarchical. This facilitated better focus on the selected ideas, but led to a situation where only incremental ideas were pursued that had only limited added value to previously defined strategic innovation projects.

The constituting role of material infrastructure for collective creativity in digital innovation relates to the recently ongoing sociomateriality debate (cf. Cecez-Kecmanovic et al., 2014 for an overview). In IS research and neighboring disciplines,

practice-based studies have gone hand in hand with a parallel emphasis on the social and material nature of organizational practices (Faulkner and Runde, 2013; Leonardi, 2013; Orlikowski and Barley, 2001). As Orlikowski (2007) puts it, the practice lens unveils that "materiality is integral to organizing, positing that the social and the material are *constitutively entangled* in everyday life" (p. 1437, italics in original). IS researchers have further argued that practices can be seen as outcome of the relationship between human agency and material characteristics of technology in use (Leonardi, 2011; Orlikowski and Scott, 2008). In this view, functional affordances of technological objects are essential material properties that facilitate the performance of some action in a specific use context (Markus and Silver, 2008). This helps to explain the observed complex interrelations between employees' networking and characteristics of material infrastructure that surrounds them, and thereby helps to specify how digital innovation changes traditional ways of innovating (Fichman et al., 2014; Yoo et al., 2010).

Innovation Process: Innovation process phases influence how collective creativity unfolds within idea hubs. Employees tend to seek unstructured and informal interactions in early innovation process phases, such as *Idea Generation & Mobilization* or *Advocacy & Screening* (cf. Desouza 2011). In our study, many employees shared early ideas only with people they trust, as for instance one employee's comparison of 'peers and preventers' reflects. However, structured and formal interactions with meetings, workshops, and fairs become more appropriate as the idea matures and proceeds to later innovation process phases, such as *Experimentation* or *Commercialization* (cf. Desouza 2011). In our study, the degree of interaction formality and employees' readiness to step out increased as the idea matured. This process of interaction formalization and structuration suggests that mutual trust plays an important role in collective creativity. Seeking help from others requires an environment of psychological safety and trust, as it implicitly reflects the tacit confession that one is unable to solve problems on one's own (Edmondson, 1999; Hargadon and Bechky, 2006). The willingness to help others requires according reward structures and codes of conduct (Amabile et al., 2014). In addition, these observations suggest that collective creativity requires continuous networking which changes in its nature over time. This insight may also be helpful when facilitating open innovation. Online support such as

crowdsourcing platforms may be useful in early innovation phases, but in later phases personal offline support that facilitates rich personal interaction is necessary whenever important decisions are made.

Personal Characteristics: Personal characteristics, such as occupational roles, reputation, personality, and organizational influence of the participating individuals influence how collective creativity unfolds within idea hubs. One overall goal of innovation management at BITS and CustomSoft is to increase the number of valuable innovative ideas that are created and developed within the company. Who creates and decides upon these ideas plays an important role in this context. Our results suggest that the involvement of influential individuals plays an important role in both companies' digital innovation practices. A number of employees point to the strong connection between an idea and the person who carries it. To some extent, this aspect might stem from the fact that the founders of the company are still present and influential. Such key characters and those people that work closely with them have substantial influence as both idea providers and idea gatekeepers. Some perceive this as positive because these key characters are also those with the most experience in judging and realizing an ideas potential value. Others criticize that this would lead to less democratic innovation processes where good ideas by less established employees would not be valued enough. This can frustrate new talents and, in the worst case, lead to a situation where the innovative capacity of a company cannot be sustained after an executive changeover.

Promotor theory and the complementary innovation catalyst theory can explain these observations. Promotor theory is based on the notion that innovation success depends crucially on networked individuals, so-called promotors, who actively and intensively support the innovation process (Witte, 1973, p. 15). They do so by providing certain resources, such as specialized knowledge, organizational influence, communication skills, and networking competencies, to overcome certain barriers, such as administrative hurdles, or lack of resources (Fichter, 2009, p. 360). Innovation catalyst theory broadens this scope from active individuals to individuals who play a passive role in innovation processes by supporting, facilitating, and promoting the innovativeness of their colleagues. Catalysts of innovation are individuals "who are able to stimulate and enhance the development of new ideas in their colleagues by

providing them with relevant knowledge and who are recognized by their colleagues as key contributors to the process of generating innovations" (Tortoriello et al., 2014, p. 2). Taken together, these two perspectives explain the observed importance of individuals who actively promote ideas on one hand, and individuals who passively support the innovation process on the other hand. However, while it can be an advantage that influential promotors and catalysts at BITS and CustomSoft carry ideas, it can also become a problem if promising new ideas are suppressed in the company's social network. Many employees pointed to the seemingly paradox character of some influential persons, who can be decisive promotors or catalysts in one situation, but in another moment the same person can be a preventer who can choke-off a good idea. This explains well why one employee criticized that having 'likes' in a social media platform may not be sufficient, and why innovation has not become a purely digital practice at BITS and CustomSoft, although both companies' business model is based on digital products and services. Digital artifacts are important to support those practices that are primarily physical (such as videoconferencing for visual meetings), and interpersonal relationships play a crucial role in choosing an idea hub.

6.5.2 Implications for Digital Innovation Practice

Digital innovation confronts firms with shortened product cycles, high demands on time to market, increased competition through distributed communities and digital platforms (such as app stores), and last but not least increases the competition for highly skilled professionals. Against this backdrop, ever more companies place a stronger focus on fostering employee-driven innovation, thereby creating various new opportunities but also placing new challenges. On the one hand, middle managers (e.g. business analysts, product managers, project managers) in the software industry are increasingly faced with the difficult challenge of balancing between organizational efficiency, stability, and innovativeness. On the other hand, innovative employees are required to carry out original combinations of digital components, be creative, break free from extant thinking patterns, deal with high degrees of uncertainty, and overcome resistance to change. Despite the wide diffusion of literature suggesting best practices, managing innovation remains a major challenge for companies, and the nearly

countless possibilities offered by new digital technologies do not make that task any easier. Our study suggests that any restructuring endeavor would benefit from explicitly supporting and fostering social networking practices through targeted implementation of idea hubs within the organization.

Our analysis of idea hubs yields rich insights into the digital innovation practices at two firms. These rich insights may be transferred to other contexts as well and help a broader class of firms to reflect on and improve their practices. For instance, the idea hubs we identified suggest specific ways in which employees can engage in collective creativity, if a company explicitly wants to encourage them to do so. We suggest that our contribution allows managers to better understand the importance of idea hubs as supporting devices of collective creativity that have to be nurtured and maintained, such that they can facilitate employee-driven innovation. Employees can draw on our contribution to better understand the importance of networking in innovation, how their choice of idea hubs depends on various factors, and how their choice leads to different outcomes. In that regard, this paper illustrates challenges and opportunities regarding the choice of idea hubs. Moreover, designers of collaboration systems can use our contribution to better understand the social contexts in which their tools are used for online networking and distinguish important from unimportant practices, as well as help specify the reasons for unfaithful use. In this regard, the described practices around idea hubs seem to be a good starting point for designing better innovation support, and for analyzing why many well-intentioned management approaches do not automatically result in well-executed innovation practices.

6.6 Limitations

We specified the digital innovation practices at two multinational European software companies, both culturally innovative but not necessarily innovation leaders. In this regard, we do not claim to have provided 'best' practices for digital innovation. Instead, part of our contribution is to identify existing innovation practices and subject them to a critical dialectical examination of their appropriateness for digital innovation. Further empirical work might be necessary to determine whether the identified practices are specific to the software companies BITS and CustomSoft, or whether the observed idea hub dialectics also hold in other contexts and conditions, for example in industrial

manufacturing or research institutions. The uniqueness of our sample has provided us with an opportunity to identify a social networking perspective on digital innovation. In doing so, we have obtained relatively detailed insights into the actual mindful interactions between individuals who engage in collective creativity. Whereas these insights offer possibilities to deeper understand digital innovation practices, they alone do not offer comprehensive prescriptions on how these practices should ideally be supported. Further research could draw on our contribution to examine how leading innovative companies engage in collective creativity to identify best practices and structured guidance for innovation.

This study focused on how employees engage in collective creativity to practice digital innovation. However, creativity and innovation do not only result from group practices. In line with previous research on collective creativity (Hargadon and Bechky, 2006), we do not disagree with the long prevailing picture of the solitary entrepreneur as main driver for innovation (Schumpeter, 1934). There may be no simple answer to the question whether genuine innovative ideas result rather from 'eureka' moments or from continuous networking practices.

6.7 Conclusion and Outlook

We set out to explore two software companies' digital innovation practices from a social networking perspective, focusing on the networking of employees who actively and enthusiastically promote ideas. Our analysis of idea hubs as nexus of collective creativity shows how employees choose from a variety of online and offline idea hubs, depending on infrastructural, individual, and process-related aspects. In this regard, this paper specifies social networking practices and, thereby, contributes to explain why employees often appropriate tools such as enterprise social media in ways that are quite different from the intended ones. In times where ESM play an increasingly important role and gain growing research attention, one should still bear in mind the major role of offline networking and human aspects.

This implies thought-provoking impulses for shaping a vision of society in the digital age. Digital artifacts provide numerous new possibilities for individuals, organizations, and economies. They afford novel forms of innovation practices in general, and social networking in particular. However, we would question whether digital technologies would eventually transform every important aspect of modern social life. In our study of digital innovation practices at two software companies, offline interactions still played a major role, particularly when important decisions were necessary. Digital technologies should therefore be in line with the emergent character of innovation practices to fully unfold their potential. There is still potential to support formal and informal networking. We therefore suggest future research and practice to also think of the broader shift in perspective, namely from managing and controlling centrally planned innovation processes to facilitating and enabling digitally networked innovation practices.

With this study, we identified and developed the idea hub as a novel theoretical perspective on the nexus of collective creativity. In doing so, we illustrated the environmental factors that influence the performance of such idea hubs, and how individuals choose them. For this purpose, we chose qualitative methods and inductive theory building to identify and describe the phenomenon. Further quantitative work could develop metrics and test the suggested interrelations and their relative effects, for instance in laboratory experiments or with surveys.

Our contribution suggests extensions to the existing literature on digital innovation. It helps explain the bottom-up emergent nature of digital innovation, enacted in the individual practices of employees; it advocates a revised appraisal of the role social networking plays in innovation practices; it illustrates a systematized account of how innovators enact practices with idea hubs; it facilitates a deeper understanding of how the active and passive roles of social networks can be unpacked; it provides an example for systematically analyzing networking practices in organizations, embracing formal, informal, online, offline, synchronous and asynchronous collaboration; and puts focus on organizational environments that favor collective innovative minds.

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7 Communicating Ideas Purposefully: Toward a Design Theory of Innovation Artifacts

(CONFERENCE PAPER)

Raffaele Fabio Ciriello, Felix-Robinson Aschoff, Mateusz Dolata, and Alexander Richter

University of Zurich, Binzmühlestrasse 14, 8050 Zürich, Switzerland

ciriello@ifi.uzh.ch, aschoff@ifi.uzh.ch, dolata@ifi.uzh.ch, arichter@ifi.uzh.ch

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Abstract: Fostering innovation is an essential task for companies, particularly in the dynamic and constantly changing software industry. Whereas it is widely acknowledged that the innovative capacity of a company depends crucially on how well it supports employees in realizing ideas, there is a lack of explicit, practitioner-oriented guidance on how these can communicate their ideas purposefully. We contribute to this field with an exploratory field study, in which we interviewed 32 experienced innovators at a major Swiss banking software provider, and collected objects through which they communicated ideas. We analyzed the collected data applying three types of causal analysis – creative causation, active causation, and passive causation. The outcome of this research is a nascent design theory that provides structured prescriptions on how to communicate ideas through what we term "innovation artifacts". In brief terms, our study shows that innovation artifacts should enable innovators to persuade and collaborate with relevant stakeholders.

Keywords: Design Theory, Innovation Artifacts, Innovation Management, Boundary Objects, Intrapreneurship, Open Innovation, Causal Analysis.

7.1 Introduction

A company's strategic position in a competitive market depends crucially on its innovative capacity (Tidd and Bessant 2011). Therefore, fostering innovation is an essential task, particularly in the dynamic software industry (Fitzgerald et al. 2008). The continuous acceleration of innovation rates forces ever more established companies to fundamentally rethink their understanding of innovation (cf. Chesbrough 2003, Christensen 1997, Desouza 2011).

In this context, a larger share of existing studies focuses mainly on establishing processes and organizational structures that facilitate innovations. According to the open innovation paradigm, companies should purposefully use both inflows and outflows of knowledge to accelerate internal innovation and expand the market for external innovation (Chesbrough et al. 2005). Similarly, the intrapreneurship paradigm describes a shift from traditionally centralized, R&D oriented organizational structures to network-based work structures (Desouza 2011). This view regards current trends such as democratization of innovation, empowerment of front line employees and a new employee generation of digital natives as the main drivers of this fundamental change (Desouza 2011, von Hippel 2005, Palfrey and Gasser 2008, Schawbel 2013). Ever more companies recognize this potential and support their employees in realizing ideas by establishing innovative organizational conditions. Popular examples include 20 percent innovation time for employees, as well as hackathons, idea contests, and informal programs where employees pitch ideas directly to executives (Schawbel 2013).

Against this backdrop, we argue that the innovative capacity of a company depends crucially on how it supports employees in realizing ideas, and particularly on the way they communicate ideas through objects. At first, an idea exists only as an abstract conception, an image in the mind of a person (Partridge 1991, pp. 303-304). That image is likely to evolve as the person sees the physical image that answers to the idea of it. In today's corporate environment, innovation is an iterative task involving social interaction with numerous stakeholders (Neyer and Maicher 2013). The well-established notion of boundary objects provides a suitable theoretical lens to understand these complex interactions and to develop and maintain coherence across intersecting social worlds (Star and Griesemer 1989). All kinds of physical or digital objects like diagrams, visual representations, or prototypes have been examined as

boundary objects (e.g. Carlile 2002, Koskinen 2005, Nicolini et al. 2012). These approaches are regarded as useful to create a better understanding of the way objects influence innovation (Carlile 2002, Neyer and Maicher 2013). However, explicit guidance on how to design and use such artifacts is scarce. Without a thorough examination of interdependencies between objects, idea communication, and innovation processes, this objective seems hardly feasible. Our research aims to bridge this gap by unifying the perspectives of innovation management and boundary objects in one comprehensive approach. In this vein we introduce the term "innovation artifact" and define it is as an underspecified representation of an envisaged solution that is used to communicate an emerging idea across intersecting social worlds in a corporate environment. In contrast to boundary objects, innovation artifacts facilitate creating a tangible preview of a possible future product or service.

We conducted an exploratory field study in a major Swiss banking software provider – an industry highly depending on continuous innovation. By interviewing 32 experienced innovators, collecting the artifacts they create and use for communicating ideas, and analyzing these *innovation artifacts* systematically, we focus our discussion on these research questions:

1. What role do innovation artifacts play in communicating ideas in a corporate environment?
2. How can innovation artifacts be designed to communicate ideas purposefully?

Applying causal analysis (Gregor et al. 2013), we examine our collected innovation artifacts with respect to their purpose, scope, form and function to extract general knowledge from them. The outcome of this research is a nascent design theory in the sense of Gregor and Jones (2007) that provides structured guidance for practitioners on how to design and use innovation artifacts. We argue that this design theory will contribute to improving the innovative capacity of a company by guiding its employees how to design artifacts to communicate ideas purposefully. Moreover, the proposed design theory helps to understand the role of innovation artifacts when employees communicate ideas in a corporate environment.

The remainder of this paper is structured as follows. Section 2 summarizes previous work in our field and motivates the need for developing a design theory of innovation

artifacts. Section 3 describes our research methodology. Section 4 comprises an exemplary analysis of our collected data. In section 5, we reflect on these findings and delineate the quintessence of our nascent design theory. Section 6 summarizes the main aspects of this paper and draws an agenda for future research.

7.2 Related Work

7.2.1 Innovation management

Management-oriented literature that focuses on fostering innovative organizational structures and conditions has become increasingly popular (cf. Kim and Mauborgne 2005, Tidd and Bessant 2011, Tschirky et al. 2010). Among the most prominent representatives of this category are the concepts of open innovation (e.g. Chesbrough 2003, Chesbrough et al. 2005, Stoetzel and Wiener 2013) and intrapreneurship (e.g. Desouza 2011, Hisrich 1986, Antoncic and Hisrich 2001, Nielsen et al. 1985). According to the open innovation paradigm, companies should open up the innovation funnel to both peripheral inside innovators (i.e. innovators inside an organization but outside the R&D department) and external collaborators (Chesbrough et al. 2005, Neyer et al. 2009). While this leads to increased connectedness and specialization, it also leads to shrinking innovation cycles and increased competition. Consequently, ever more companies shift from traditionally centralized, R&D-oriented organizational structures to decentralized, network-based work structures (Desouza 2011). As opposed to the centralized paradigm, where isolated groups of experienced professionals develop ideas with a 3-5 years horizon, innovation is increasingly driven by so-called intrapreneurs. These are employees that share the drive and zeal of entrepreneurs, but rely on resources provided by their organization. They do so because they want to focus on developing ideas, but need the organization's support when it comes to providing human, technological or financial resources, and established networks of partners or customers (Desouza 2011).

Some also refer to this phenomenon as internal open innovation, as opposed to external open innovation with collaborators outside the organization (Stoetzel and Wiener 2013, Neyer et al. 2009). Ever more companies focus on strengthening internal innovation and empowering employees, hoping to benefit in two regards: Firstly, they seek to enhance the company's innovative capacity. Secondly, offering an innovative

working environment could attract further highly skilled employees. Prominent examples of products that result from intrapreneurial efforts are Google's AdSense, News, and Mail, Facebook's like-button, and post-it notes at 3M (Schawbel 2013). Fostering internal innovation, however, places a stronger focus on understanding how employees exchange ideas across functional, technical, and organizational boundaries (cf. Leonardi 2011). Previous research has built on the notion of boundary objects to examine these complex interactions (e.g. Carlile 2002, Carlile 2004, Nicolini et al. 2012), as we outline in the next section.

7.2.2 Boundary objects

In the software industry, advancing ideas requires interaction with numerous distinct stakeholders, ranging from customers and external partners over business analysts, software architects and software engineers up to marketing and sales personnel, project managers and executives (Neyer et al. 2009). Any one of these stakeholders has a different perspective on potentially valuable ideas. Hence, to advance an idea, it is decisive to maintain its integrity in different contexts (Desouza 2011), because people tend to make sense of new things according to their existing mental model. For example, when Thomas Edison introduced the newly invented light bulb, he deliberately imitated features of existing gas lighting, so that people who had been using that technology for about 50 years could make sense of the innovation (Hargadon and Douglas 2001). In other words, demonstrating a novel idea via familiar living examples facilitated mental model matching among observers, thereby creating a common understanding about something that hasn't been there yet (cf. Smith and Shaffer 2000). Some refer to this phenomenon as interobjectivity (Latour 1996, Neyer and Maicher 2013, Nicolini et al. 2012), as opposed to intersubjectivity, which describes the practice of reaching a consensus through professional disputes and qualified subjective evaluations (Tschirky et al. 2010).

A considerable amount of research has examined constellations of interobjectivity in innovation under the well-established notion of boundary objects, which are defined by their ability to develop and maintain coherence across intersecting social worlds (Star and Griesemer 1989). In the context of innovation, boundary objects are perceived as

objects that facilitate preserving an idea's integrity as it travels across technical, functional and organizational boundaries (Carlile 2004, Neyer and Maicher 2013, Rehm and Goehl 2013). For example, Carlile (2002) vividly illustrates boundary objects in new product development with the case of a manufacturing engineer struggling to persuade a design engineering board of an idea. After several unsuccessful attempts, he finally came up with a drawing that reflected the mental models of the design engineers. Only then were they willing to collaborate and advance the idea. In other words, although the arguments did not change at all, he enabled the audience to mentally dock on by establishing a shared syntax, i.e. creating a boundary object. Previous research has examined various classes of boundary objects as enabler of interaction in innovation (Carlile 2004, Neyer and Maicher 2013). These range from tangible artifacts such as PowerPoint slides, standardized forms, sketches, drawings, IT artifacts and prototypes (Carlile 2002, Nicolini et al. 2012, Schoeneborn 2013), over more abstract objects like metaphors (Koskinen 2005), discussions and research projects (Kimble et al. 2010), up to portfolios of objects, which are referred to as composite boundary object (Rehm and Goehl 2013).

Neyer and Maicher (2013), however, argue that the notion of boundary objects in itself does not suffice to capture the multi-faceted nature of work performed by objects in innovation. Building on the novel analytical framework proposed by Nicolini et al. (2012), they study the role of objects in innovation following a pluralist approach that embraces *boundary objects, epistemic objects, activity objects,* and *material infrastructure*. Epistemic objects raise curiosity and acquire emotional and social binding among their creators by embodying "*what one does not yet know*". In a case study, they describe a novel bioreactor as epistemic object of a cross-disciplinary research project. Similarly, activity objects motivate interaction and direct manipulation among observers. Typical examples are early prototypes that allow exploration of different options and discussion of design evolution (in the sense of Gutierrez 1989, Doll 2009, Houde and Hill 1997, Rosson and Carroll 2002). Lastly, objects that perform subtle background work such as e-mails or phone calls are subsumed under the term material infrastructure. In closing, Nicolini et al. (2012) postulate that researchers shall examine how people work toward and with these different classes of objects in practice to develop a better understanding of their activities. Neyer and Maicher (2013) follow this call and examined objects of

interactive innovation, concluding that this pluralist approach contributes to a deeper understanding of "*what works when*". However, while descriptive research on boundary objects contributes a lot to describe and understand the nature of the complex interactions associated with innovation, it leaves undone the task of developing sound change programs (cf. Gregor and Jones 2007, Van Aken 2004, p.220). Hence, we identify a lack of systematic investigation on formulating practitioner-oriented guidance regarding the design and application of innovation artifacts that are directed to the future. We argue that both researchers and practitioners will benefit from complementing existing description-driven research with prescription-driven research that provides targeted instructions for innovation artifacts. The next section illustrates how we aim to close this gap.

7.3 Research Design

7.3.1 Exploratory field study

To answer our research questions, we conducted an exploratory field study with one of Switzerland's major banking software providers (in the following termed BITS – Banking IT Solutions). Founded in the 1990s, the company rapidly grew to an international market leader in the banking software sector, until 2008's financial crisis increased the pressure to innovate and diversify its solution portfolio. Today, around 1300 employees in two development centers and seven subsidiaries worldwide collaboratively innovate with customers (mostly private, retail, and universal banks), partners (specialized units e.g. for technical or outsourcing problems), and universities. It is therefore an excellent subject for examining how employees exchange ideas across boundaries through innovation artifacts. After having captured a detailed snapshot of the innovation activities at BITS, we reflected on our findings and elaborated a set of more general guidelines that are applicable to a broader class of problems. The following sections present the single steps in further detail.

7.3.2 BITS dataset

We ground our analysis on three data sources: 1) interviews with 32 experienced innovators affiliated with or employed at BITS, 2) innovation artifacts that we collected

throughout the study, and 3) further firm information collected from websites, intranets, and pre-study project reports. The data was collected and processed in a team of four researchers who were in continuous exchange with the participants of the study and further BITS representatives. To strengthen the validity of our data, we consulted existing literature on innovation management and boundary objects (cf. section 2) to form a-priori constructs. This also helped us to prepare an interview questionnaire, and a short exposé that was used to inform participants of the topic.

The interviewees were selected after a thorough examination of the organizational configuration at BITS. Executives helped us to contact experienced deciders, sponsors, innovators, and also external partners from different departments and different roles. On average, our interviewees have 7.9 years of working experience with BITS. All 32 interviews were semi-structured interviews of approximately 90 minutes duration, conducted by one or two researchers. Baseline questions include 1) educational background and previous working experience with innovative projects at BITS, 2) a precise description of innovation artifacts the person created, including to whom an artifact as targeted, why the artifact was created in that form, and depending on which contextual condition the person decides on an artifact in general, 3) a precise description of situations where an innovation artifact functioned well or poorly to propagate an idea, including the assumed reason for success or failure, 4) the person's experiences regarding cost and benefit when creating innovation artifacts, and 5) which innovation artifacts the person prefers for deciding over an idea. The interviews were recorded and transcribed by all four researchers following a denaturalized approach (Weston et al. 2001), which focuses on meanings rather than on accents of the interviewees. To increase internal validity, we crosschecked the transcriptions among the research team, and analyzed the cases for discrepant evidence (Weston et al. 2001). During the interviews, we also took field notes to memorize the important aspects on artifacts. The real-life observations allowed us to understand the complex interactions between generating ideas, creating innovation artifacts, communicating them to relevant stakeholders, and realizing ideas.

We then imported the raw transcriptions into the qualitative data analysis software MAXQDA. Two researchers developed a codebook with 201 codes, and crosschecked their codings to increase intercoder agreement (DeCuir-Gunby et al. 2011). Two

additional researchers carried out coding checks to ensure intercoder reliability and develop a shared conception of reflection (Weston et al. 2001). We further elaborated the codebook in weekly focus groups (Krueger 2009) to identify themes from various interviews and derive new codes *in vivo* from the data (DeCuir-Gunby et al. 2011). Basic coding dimensions included: 1) the purpose of creating an artifact 2) the involved actors (e.g. a co-worker, customer, superior, or sponsor), 3) the form of the artifact 4) the interviewee's judgment of an artifact (positive or negative), and 5) the innovation process stage in which it was applied (idea generation, screening, experimentation, commercialization, diffusion – cf. Desouza 2011). The coded units were phrases, sentences, or paragraphs (Weber 1990). The codes also helped us to find relevant snippets quickly using MAXQDAs code retrieval tool.

Simultaneously, we also collected the artifacts that were mentioned during the interviews. Some interviewees took us to their desk and gave us the artifacts directly afterward, others sent them via mail. Additionally, we were allowed to collect further related artifacts from BITS' intranet. The artifacts are no stand-alone entities, but related to various recent innovative projects at BITS. We are provided with an extensive set of artifacts from various projects (e.g. the e-banking project mentioned in 3.1) and with different degrees of maturity, ranging from whiteboard sketches over diagrams, wireframes, structured documents, PowerPoint slides, and prototypes. In consultation with BITS executives and interviewees, the artifacts were stored on a shared storage, where the four researchers could thoroughly analyze them. In total, we collected and analyzed 216 innovation artifacts. We relied on guidelines for case-based theory building (Eisenhard 1989, Eisenhard 1991), and particularly on genre analysis (cf. Richter and Riemer 2013, Riemer and Filius 2009, Yates and Orlikowski 2007) to classify the artifacts, whereby we inductively identified the following ten categories:

1) Informal speech: Well-prepared oral descriptions, e.g. elevator pitch, Daily Scrum discussion
2) Handwritten sketch: Pen and paper, whiteboard, post-it or flipchart.
3) Usage description: Describe users, along with their goals, activities, and expectations from a system, e.g. user stories, scenarios, or storyboards (cf. Rosson and Carroll 2002)

4) Design sketch: Focus on the user interface (UI) and the interaction between the end user and the system, e.g. wireframes, UI mockups, or screenshots (cf. Sefelin, Tscheligi and Giller 2003)

5) Software diagram: Conceptual model of a system, e.g. a drawing in the unified modeling language (UML), or business process modeling notation (BPMN) (cf. Cherubini et al. 2007).

6) Issue: A functional customer request, e.g. a ticket in an issue tracking system or a JIRA story

7) PowerPoint presentation: Slideware created in MS PowerPoint (cf. Yates & Orlikowski 2007)

8) Structured text document: Template with predefined sections, e.g. a software specification

9) Business case: A quantitative extrapolation addressing the questions how many resources have to be invested, and how much return on investment can be expected over a period of time.

10) Prototype: An early sample of an innovation used for exploration of possible solutions (cf. Doll 2009, Gutierrez 1989, Houde and Hill 1997)

The process continued throughout informing Bits executives of our findings by collaboratively writing a project report, which also served as basis for this paper. The report findings were continuously refined through presentations and discussions in workshops and meetings with Bits representatives. Subsequently, we further advanced our sense making of the extensive data set using causal analysis (Gregor et al. 2013), as the following section illustrates.

7.3.3 Research methodology

Our study can be classified as design science research (Peffers et al. 2007, March and Smith 1995) in that we seek to develop a prescriptive, practitioner-oriented design theory (Gregor and Jones 2007, Walls et al. 1992) that solves an important business problem (Hevner et al. 2004). We started with an extensive literature research on innovation management and boundary objects, as described in section 2. Building on existing studies in the area of our interest, we wanted to find out what innovation

artifacts are used to communicate ideas in a corporate environment, but also why, with whom, and in which situations an artifact is a useful medium. These kernel theories not only helped us to ensure that the study is framed correctly, but also provided *justificatory knowledge* (Gregor and Jones 2007) for developing our nascent design theory. Acknowledging guideline 2 from Hevner et al. (2004), we could also verify that the executive board of BITS considers poor support for employees in realizing ideas a serious business problem. The outcome of our research is an information systems design theory in the sense of Gregor and Jones (2007), of which we will present the following components in this paper.

The *purpose and scope* of a design theory constitute a set of goals that specify the type of artifact the theory applies to. We extract the purposes of innovation artifacts from our dataset by building on the work of Gregor et al. (2013), who propose a framework for developing design theories through inductive processes of reflection and abstraction. In this context, reflection refers to the process of learning from experiences made in the past, and abstraction describes the process of deriving generic features from observed instances of artifacts. In the light of the uncertain nature of innovation, reflective judgment helps to identify essential conditions that are applicable to a broader class of problems (Lee et al. 2011). Against this backdrop, Gregor et al. (2013) argue that design theorizing operates in an instance domain and an abstract domain (cf. Lee et al. 2011), and that design theory can be extracted from instances of artifacts through three intertwined types of causal analysis (Gregor and Hovorka 2011). This approach helps us to identify *principles of form,* i.e. enabling conditions of an artifact's characteristics and its context of use, as well as *principles of function*, i.e. deliberate acts or interventions that facilitate achieving these goals. Gregor et al. (2013) demonstrate the applicability of their framework via a simple illustration of extracting design theory from a jug, which we summarize in the following.

Firstly, *creative causation* helps to reflect on the *purpose and scope* by focusing back on the source of novelty of a design idea for an artifact. For example, a creative idea might have struck a potter to create a better artifact for pouring liquid (i.e. a jug) by adding a handle and spout to a container with an opening. Secondly, *active causation* helps to reflect on *principles of function* by analyzing the way an artifact operates to initiate the trajectory of a change, e.g. adding liquid through opening, lifting the jug by the handle,

and pouring liquid through the spout. Thirdly, *passive causation* helps to reflect on *principles of form* by focusing on an artifact's affordances, i.e. essential material properties that facilitate the performance of some action in a specific use context (Markus and Silver 2008, Gregor and Hovorka 2011). For example, a jug's principles of form may be seen as 1) choosing a shape that has the capacity to hold liquid, 2) providing an opening through which liquid can be added, 3) providing a handle that allows picking up the jug, and 4) providing a spout that facilitates pouring liquid. It is further argued that collecting field notes throughout the design process may facilitate these three types of analysis (Gregor et al. 2013). In that sense, we regard a large share of our collected innovation artifacts as traces of a design process, enabling us to reconstruct problems the innovators faced, but also how they performed deliberate actions to master these challenges. Acknowledging guideline 5 from Hevner et al. (2004), we apply this abstraction framework rigorously to inductively extract design theory from our dataset. To make the analysis more transparent, we list the reflective questions that help identifying the design theory components at the beginning of each respective subsection in section 5.

7.4 Results

By means of an exemplary analysis, this section demonstrates how we apply causal analysis to extract design theory from our dataset. The sample artifacts presented in this section are ordered by their degree of maturity in which they represent an idea, ranging from low-maturity whiteboard sketches over more elaborate diagrams and documents, up to functioning prototypes.

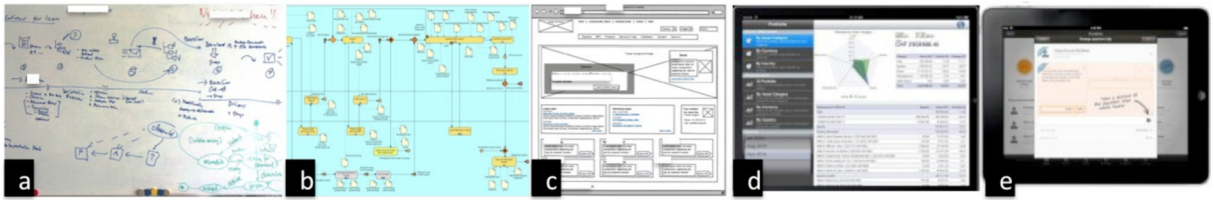

Figure 7-1 : Exemplary trajectory of an innovation with corresponding artifacts at different degrees of maturity. From left to right: Whiteboard sketch, BPMN diagram, wireframe, UI mockup, prototype.

As we learned from the interviews, whiteboard discussions are a typical setting at BITS in which groups of software engineers, software architects, lead developers, business analysts and product managers meet often to brainstorm, develop and structure new ideas, explore new topics, breakdown large topic blocks and exchange specialized knowledge. One lead developer regards this as "*the simplest and most efficient way to build consensus and develop a common understanding*" (*I6*). Some project teams regularly conduct two-hourly, weekly sessions where current ideas are discussed and further developed via whiteboard sketches in small groups: "*I find it most efficient to meet in small teams and discuss new ideas on the whiteboard. […] Simply draw some rough sequences of screens, doesn't really matter how it looks like*", a software engineer states (cf. figure 1a, *I1*). It is therefore not surprising that most department managers prefer whiteboard sketches when new ideas are communicated to them. One should reportedly not spend too much time on large texts, diagrams or prototypes, but rather provide a well-prepared oral description and discuss the idea as early as possible in a whiteboard discussion. To convince c-level management, however, one reportedly has to present more elaborate artifacts such as PowerPoint slides. Once a consensus is reached, the sketches are often photographed and put in structured documents like software specifications (cf. IEEE 1984) or intranet wiki pages. Some use computer-based modeling tools to redraw the sketches beforehand, such that they can be reused as working artifact for further developments (cf. figure 1b). In this regard, several interviewees from different organizational units emphasize that adhering to a standardized modeling notation such as UML or BPMN is crucial to ensure a common understanding, especially in communication with external partners or new employees with little or no firm experience. Such diagrams, however, are reportedly misplaced in communication with customers or non-technical partners, as they generally do not understand the notation.

In subsequent phases, many interviewees reported of having created more elaborated artifacts to gather quick feedback from external partners or customers. For example, one project team discussed early ideas with external interaction design specialists based on a first software specification for a tablet app, which should assist financial advisors in client consultation. In most units of BITS, software specifications are created on the basis of standardized document templates with predefined sections and mandatory content descriptions, which force the authors to write ideas out precisely. Based on this specification, the designers created a set of wireframes (cf. figure 1c), i.e. rough schematic representations of UI screens that assimilate line drawings. These wireframes were used to perform a customer walkthrough of a typical financial advisory encounter. This was reportedly a suitable instrument to discuss the raw ideas and get an overall impression whether the proposed system could be helpful in practice: "*We prepared an advisory use case from A-Z, such that one can sort of click through the wireframes. This went down quite well. In general, actually, feedback only comes when they see it graphically in front of them. Most of our customers cannot imagine what it means when they just read text. A specification doesn't help much there. The desired feedback only comes when they really see it*", a software engineer reports (I1). Similarly, interviewees from other units reportedly draw wireframes on paper to structure their thoughts and think an idea through for themselves before they start to implement it, because it helps to "*strike out all the bad things about an idea*", one release manager states (I11). This interviewee calls for a more elaborate innovation process that demands concrete artifact deliverables. Thereby, the awareness of employees and managers to create innovation artifacts could be increased and the process could be more structured.

Some interviewees, however, also warn of the incompleteness of wireframes: "*When I talk to someone who has a certain technical understanding, then I can use UI mockups. Something more vague, and it can contain omissions. As soon as I go to someone who doesn't work with computers regularly, I can't do that. They don't understand the abstraction. We have seen that several times*", a lead developer contends (I6). Similarly, another software engineer reports on a project where the team got tangled up in long discussions with customers about sample screens for a portfolio management view (cf. figure 1d). As a seemingly illustrative example, the screen had visualized the financing plan for purchasing a house, using simple pie charts, bar graphs, and line diagrams. But the

private bank advisors protested that this wasn't an actual use case, because their customers can buy houses in any event and do not need such a financial plan in their portfolio. They would rather be interested in optimizing cash flows. "*Transferring the exemplary financing of a house to doing the same thing with cash flows turned out to be difficult. Hence, the closer to the real life situation of the advisor, the better*", the software engineer concludes (I1).

A functioning prototype can help to overcome this challenge. One interviewee describes a positive experience with a click-through prototype in communication with customers: "*The prototype didn't have much functionality, it simply visualized a portfolio in simple pie charts. But it was insofar helpful as the customer could see 'ah, that's how it could look like, these are the possibilities, if you turn the iPad around you can visualize more information.' The sole looking and touching helped to understand what we wanted to show the customer.*" (I1) However, choosing the right degree of fidelity and polishedness is crucial when using prototypes in communication with customers, because they tend to confuse an early prototype with the final solution. "*Very often, we get tangled up in extremely tedious discussions about things that are completely irrelevant. Things like, if we build that in green or blue does not matter. Then again, some things are not even brought to the table because the customer thinks that's easy*", a system architect says (I12). Other interviewees describe situations in which prototypes stimulated their own creativity. For example, one interviewee reports on an idea that struck him while evaluating the mobile payment module for a smartphone prototype: "*It bugged me that you had to typewrite the 20-digit reference number*[1]*, even though there's a built-in camera*." (I29, cf. figure 1e) So he tried out image recognition frameworks and built a prototype to scan and automatically process payment slips. He occasionally demonstrated the progress to his colleagues, and at some point, the project management granted resources to build this module for the productive system. In more specialized areas, such as credit check, trading, taxation or core banking in general, prototyping is more difficult, because more specialized domain knowledge is needed before an idea even evolves. Yet still, two experienced software

[1] The *reference number* is a transaction identification code on the Swiss *Einzahlungsschein Orange* (orange payment slip).

architects report that they regularly create "*Excel sheet prototypes*" to demonstrate how the system would calculate a new formula (I20, I14).

However, one product manager contends that in many projects, there are hardly any possibilities to try out too many things due to tight schedules. When time pressure is high, a business case can be more useful than a prototype, he states, because the respective deciders on the banks' side are mainly interested in the actual savings the new software provides. While the costs of a development can be estimated quite precisely, one challenge is to estimate the benefits as well. A well-prepared business case can master this challenge. In this context, the business case is mostly used to persuade c-level management of an idea. One critical long-established employee however warns of the tempted reduced complexity that is signaled by a business case, because the rather quantitative nature of business cases does not fit the "*spirit of the idea itself" (I24).* This interviewee criticizes the belief that the feasibility of an idea can "*be proven on an Excel sheet*". According to this interviewee, it would be more helpful to "*really believe in the essence of the idea*". In his experience, market predictions based on prototypes can actually be much more accurate, especially if they create excitement and the wish to fulfill the idea among observers.

Other interviewees concur and describe their positive experience with a prototype app for the iPad, for which extraordinary persuasion efforts came into operation: All CEOs and CTOs of BITS' customers received an iPad with the said prototype app installed as a Christmas present. However, as the aforementioned interviewee states, this was not yet all, "*because we wanted to present something. So we created a photo storyboard, defined use cases, storylines, and roles, and imagined one day in the life of these personas with all the cool features we want to build. We put all that into the photo storyboard and this was enormously persuading, the customers were excited. They understood: There are people with ideas here*." (I24) Reportedly, this visual and appealing representation of the future product helped the bank CEOs to anticipate how the banking industry could change in the future, and was a successful means to persuade further investment in the project.

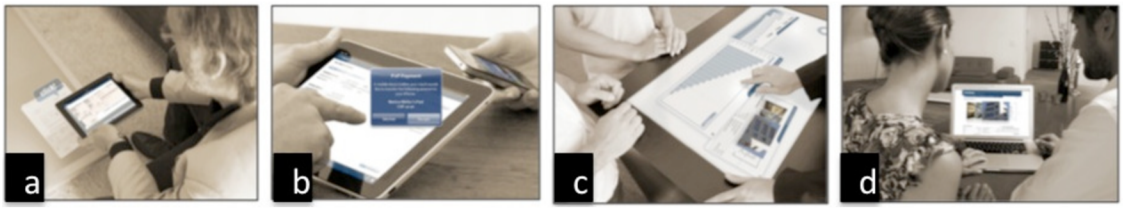

Figure 7-2 : Excerpts from the photo storyboard prospecting future mobile banking products. From left to right: Payment slip scanner, Peer-to-peer payment, financial advisory, web banking.

The photo storyboard was reused in various contexts. Not only was it presented in internal tech talks to inform other units of the company of current developments and recruit collaborators. Reportedly, it also turned out to be more persuading for sponsors than the respective business case that was elaborated beforehand. Furthermore, the photo storyboard was frequently used by marketing and sales personnel, for example in brochures and websites.

To summarize, we have captured numerous situations where practitioners collaboratively construct and exchange innovation artifacts, such as handwritten sketches, usage descriptions, software diagrams, design sketches, PowerPoint presentations, structured documents, or prototypes. The dataset contains precise description of the purposes for which the interviewees created artifacts, the rationale behind choosing the respective form, and the actions that were necessary to get the artifact to work. The presented data provides a detailed snapshot of innovation in a software provider, and constitutes essential information for constructing our design theory, which we present in the following section.

7.5 A Design Theory of Innovation Artifacts

In this section, we delineate a nascent design theory. In the process of writing this paper, we repeatedly went through the coded interviews and collected innovation artifacts. To structure our analysis, we adapted the reflective questions included in the abstraction framework proposed by Gregor et al. (2013, cf. section 3.3), which are listed at the beginning of each section in italics.

7.5.1 Purpose and scope

To identify purpose and scope, we reflected on the original problem-solution space the innovator faced when creating an innovation artifact, answering the questions: "*What was the problem* [the innovator] *originally perceived? What is the goal of the artifact? How did the original design idea come about? Can you give the design idea a name?*" (Gregor et al. 2013)

The purpose of the proposed design theory for innovation artifacts is to provide practitioner-oriented guidance on how to create and use artifacts to communicate emerging ideas purposefully. From an employee's perspective, the guidelines constitute a valuable instrument on how to exploit the potential of tangible representations for realizing an idea. From a manager's perspective, the design theory may facilitate better structuring of innovation processes by demanding concrete artifact deliverables. Our design theory is built from data collected at a software provider, and is therefore likely to best suit the innovation practices of the software industry.

As our study shows, innovation artifacts can bring about change in a variety of situations. They may serve as a communicational bridge when people across technical, functional or organizational boundaries communicate potentially valuable ideas. We observed that innovation artifacts are used as a means to propagate an emerging idea, and to create tangible representations of envisaged products or services. Reportedly, innovation artifacts such as handwritten sketches or wireframes can be useful in a private space, confronting the innovator with a first prospect of a new idea, thereby advancing the chain-of-thoughts and inspiring further development. These early innovation artifacts give the creator an impression of the potentials and constraints that emerge when the idea meets the realm of reality. As the idea matures, more elaborate innovation artifacts such as structured documents or prototypes reduce uncertainty, complexity, and the number of possible outcomes. In addition, we learned that an innovation artifact can be used to promote sensemaking when communicating ideas to another person, collect input or even create a social coalition of advocates. Finally, innovation artifacts such as business cases can support complex decisions and be an important tool to transgress the many quality gates that are associated with innovation processes. This means that the innovation artifact can be a crucial tool to persuade

important stakeholders along the innovation trajectory like peers, superiors, gatekeepers, sponsors or customers.

7.5.2 Principles of form and function

To identify principles of form, we reflected on an innovation artifact's provided affordances to identify design characteristics that facilitate the achievement of its goals, answering the questions: *"What material properties did the designer deliberately build into the artifact to enable it to achieve its purpose? What contextual conditions are observed to enable the emergence of the desired affordances? Which user groups perceive which functional affordances of the artifact?"* To identify principles of function, we reflected on reported series of actions necessary to facilitate the achievement of an innovation artifact's goals, answering the questions: *"Which acts or interventions have to be performed in order to reach a specific goal? Who are the agents? What are the observed effects? Why are they necessary (is there underlying support from justificatory knowledge)"?* (Gregor et al. 2013)

In brief terms, innovators should purposefully design and use innovation artifacts to persuade and collaborate with relevant stakeholders. While pursuing these goals can be intertwined (cf. Petty and Cacioppo 1984), it is important to bear their distinctiveness in mind, as we outline in the following.

Principle 1: An innovation artifact should help persuade relevant stakeholders through proof-of-value and proof-of-concept.

Innovation is by definition risky, because the outcome is unpredictable and substantial investment is required before the desired benefit can be achieved. Hence, an innovation artifact should facilitate persuasion of decision makers to grant sufficient resources for realizing an idea. To be persuasive, the artifact should make clear what exact problem is to be solved, and what would be the potential impact of the idea it represents, including the cost of not adopting the idea (cf. Desouza 2011). Concisely elaborating both a proof-of-value and proof-of-concept can master this challenge.

A proof-of-value addresses doing the right things. Persuading sponsors requires the innovator to illustrate that an idea is valuable and generates a clear benefit for a relevant target group. A concise management summary comprising a distinguished problem statement and the main contribution in few sentences can meet this

requirement, as well as a well-prepared business case. Additionally, persuading relevant stakeholders also calls for a certain degree of enthusiasm. As we learned from the interviewee's experiences with the photo storyboard (cf. figure 2), the presenter should visibly believe in the essence of the idea that is represented by an artifact and guide observers to really believe in this essence, too. Choosing an appealing and vivid representation for the artifact can create emotional attachment to the idea among observers, and awake the desire to fulfill it (cf. Smith and Shaffer 2000, Taylor and Thompson 1982). This proposition is consistent with action models in which beliefs about the future guide subsequent individual and organizational action (cf. Grégoire et al. 2010).

A proof-of-concept addresses doing the things right. Safeguarding long-term stakeholder commitment for granting resources calls for demonstrating feasibility of an idea. Pursuing completeness and consistency of decision-relevant information is vital in this context. Hence, an innovation artifact should reduce complexity by highlighting the important aspects of an idea while leaving out the dispensable ones, thereby reducing the number of possible outcomes. A functioning prototype can meet this requirement. The financial advisory app (cf. figure 2c) falls into this category.

Principle 2: An innovation artifact should help fuel collaboration by acting as boundary object and activity object.

In today's corporate environment, ideas are constructed and negotiated in social interaction and collaboration, rather than elaborated by a genius mind in a quiet chamber (Desouza 2011). However, while most organizations do not lack ideas, resources for realizing them are often scarce. In the face of daily business responsibilities, an innovator will hardly be able to set an idea in motion without investing a substantial amount of spare time in it. Hence, an innovation artifact should facilitate creating a coalition of advocates with relevant expertise, and making the idea tangible to collect quality feedback quickly. That means an innovation artifact should provide high interpretive flexibility, i.e. the extent to which an artifact multiple interpretations about how it should be used (Fichmann 2004, Orlikowski 1996). Providing affordances of activity objects and boundary objects (Nicolini et al. 2012, cf. section 2.2) can master this challenge.

Innovation artifacts that act as activity objects facilitate interaction among peers through embodying a certain degree of incompleteness. In doing so, they enable collaborators to create new tangible manifestations and take an idea to higher degrees of maturity. Hence, innovation artifacts should serve as working basis and contain targeted instructions on how something should be done. In contrast to "closed" artifacts like PowerPoint presentations or software specifications, more "open" artifacts like quick design sketches, wireframes, or whiteboard sketches can meet this requirement. The whiteboard sketches and wireframes (figure 1a, c) fit into this category.

Innovation artifacts that act as boundary objects facilitate preserving an idea's integrity in different contexts through adhering to a shared language. These innovation artifacts maintain coherence and create a common understanding across technical, functional, and organizational boundaries, thereby promoting sensemaking and mental model matching among allies. To meet this requirement, an innovation artifact should be compatible to the receiver's mental model, and transport an idea's essence even without the presence of the author. UML and BPMN diagrams can meet this requirement, as well as structured document templates that force the authors to concisely elaborate an idea, especially when complementing the text with meaningful visual representations or powerful analogies. To conclude, we argue that innovation artifacts embody a lot of valuable knowledge that emerges during the process of constructing and negotiating an idea. This embodied knowledge should be preserved, as it can be a fruitful source of inspiration and research afterwards. In this regard, the photo storyboard (figure 2) also fits into this category.

7.6 Conclusions and Future Work

These days, ever more companies recognize the potential of user-driven innovation and seek to support employees in realizing ideas by establishing innovative organizational conditions. Against this backdrop, we argue that the innovative capacity of a company can be significantly enhanced through providing structured guidance on communicating ideas through innovation artifacts. Whereas previous studies provide suitable theoretical lenses to understand the complex interactions associated with these tasks, explicit prescriptions for designing and using innovation artifacts are still scarce. We seek to close this gap by conducting an exploratory field study in a banking

software provider. To answer research question 1, we focus our study on examining how experienced innovators create and use innovation artifacts. In particular, we asked our 32 interviewees what ideas they communicated to whom, through which innovation artifacts, in which situations, and which factors decide over success or failure of an artifact. We build on boundary object literature to understand these complex interactions, and introduce the term *innovation artifact* itself as a more specific conceptualization. Innovation artifacts are defined by their ability to create an underspecified representation of an envisaged solution that is used to communicate an idea across intersecting social worlds. This conceptualization helps us to focus our discussion on the role artifacts play in realizing ideas. To answer research question 2, we rely on causal analysis to inductively extract a nascent design theory from the collected innovation artifacts (Gregor et al. 2013, Gregor and Jones 2007). The range of identified innovation artifacts is broad and comprises whiteboard sketches, software diagrams, usage descriptions, PowerPoint slides, prototypes, and business cases. In brief terms, innovation artifacts should enable innovators to persuade and collaborate with relevant stakeholders.

Our findings have to be seen in the light of some limitations. Firstly, although our dataset is very extensive, it has been gathered in a single company, and therefore needs further empirical work. Secondly, this contribution presents only the quintessence of our theory and requires further refinement. To address these issues, we currently prepare a comparative study with an additional software company to validate, extend and refine the design theory. Additionally, we develop an innovation coaching concept to evaluate the design theory. This includes querying the perceived persuasiveness among stakeholders with various levels of expertise of an idea that fulfill the two design principles to various extents (cf. Guadagno et al. 2011). We believe that our nascent theory will provide a substantial theoretical contribution, because it facilitates consolidating innovation management and boundary object theories, which both have an essential impact on IS research. To the best of our knowledge, our study is the first one to inductively develop a design theory from innovation artifacts collected in a corporate environment. In doing so, we illustrate via a practical example how inductive processes of reflection and abstraction leverage extraction of a design theory (Gregor et al. 2013).

We retain that extending this work with guidelines for formulating remaining design theory components would be a fruitful topic for future research. We follow the call of van Aken (2004), who advocates for more prescription-driven research that provides solutions for practical innovation problems. Similar recent research projects indicate a growing popularity of that approach (e.g. Ahlemann et al. 2013). However, description-driven research still dominates in our field of interest. This approach provides indeed a better understanding of these problems, but leaves undone the task of developing sound change programs. In line with other authors (e.g. Müller and Thoring 2011), we therefore argue that future research should place a stronger focus on innovation artifacts to better understand the complex interactions in innovation, and link the findings back to existing conceptualizations of innovation management and boundary objects.

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8 Enabling Intrapreneurship with an Idea Screening Framework

(JOURNAL ARTICLE)

Raffaele Fabio Ciriello, Alexander Richter, and Gerhard Schwabe
University of Zurich, Binzmühlestrasse 14, 8050 Zürich, Switzerland
ciriello@ifi.uzh.ch, arichter@ifi.uzh.ch, schwabe@ifi.uzh.ch

This paper is currently under review at the International Journal of Entrepreneurship and Small Business (IJESB). It is a substantially revised version of a paper entitled "Designing an Idea Screening Framework for Employee-driven Innovation", which has been previously published in the Proceedings of the 49th Hawaii International Conference on System Sciences (HICSS2016), Hawaii, USA

Abstract: As ever more companies encourage internal employees to become entrepreneurs within the company realm (also known as 'intrapreneurship'), a surplus of promising ideas has become reality in many organizations – often exceeding the available resources to develop them. Recent research calls for designing IT-supported, comprehensive, multi-attributive idea screening throughout the whole innovation cycle. This paper addresses these calls by suggesting an Idea Screening Framework (ISF) and shows with a prototype how the framework can enable intrapreneurship by facilitating the evaluation, selection, and tracking of ideas for managers and intrapreneurs. The ISF is grounded in literature and was empirically validated with data that we collected from a two-year field study in a multinational banking software provider. It provides useful starting points for enabling intrapreneurship and has the potential to support intrapreneurs in connecting and collaborating with each other across organizational and geographical boundaries.

Keywords: Intrapreneurship, Employee, Innovation, Management, Idea, Screening, Framework, Evaluation, Selection, Tracking, Small and Medium-sized Enterprises (SME), Information Systems (IS)

8.1 Introduction

Fostering innovation has become a fundamental and necessary practice for companies to thrive and survive in today's globalized and competitive markets (Chesbrough, 2003; Tidd and Bessant, 2011). Against this backdrop, intrapreneurship emerges as increasingly important phenomenon (Desouza, 2011). Intrapreneurship, sometimes also referred to as employee-driven innovation or corporate entrepreneurship, is defined broadly as an individual's ability to be inventive and entrepreneurial within the parameters of an organization (Desouza, 2011, p.5). This poses new challenges for innovation management, as the number of potentially valuable ideas usually exceeds an organization's capacity to put them in practice (Lindič et al., 2011). A recent global study among 1.600 executives found that selecting the right ideas was among the top three obstacles when investing in innovation (Andrew et al., 2010). Moreover, idea screening is a complex, cognitively challenging task imbued with uncertainty, and a recent study among 330 managers found that organizations using information systems (IS) are more effective in screening collected ideas (Schulze et al., 2012).

Alongside with the screening process itself, studies have shown that intrapreneurship also means that the intrapreneurs need support from experienced colleagues that challenge and enrich their ideas (Desouza, 2011; Fichter, 2009; Høyrup et al., 2012; Tortoriello et al., 2014). For such facilitators, it is important to maintain an overview over existing ideas and initiatives within the company. As such, intrapreneurship crucially depends on appropriate screening (i.e. evaluation, selection, and tracking) of ideas that intrapreneurs and facilitators carry out. Hence, the need for comprehensive, multi-attributive idea screening support throughout the whole innovation cycle has recently been brought forward (Gressgard et al., 2014; Riedl et al., 2010; Schulze et al., 2012). For this reason, we raise the guiding research question: *Which criteria should be considered to screen ideas in intrapreneurship*?

Our contribution is threefold. Firstly, we elicit and illustrate the requirements for supporting idea screening and make a case of the intrapreneurship practices in a software firm. Secondly, we identify a set of criteria for screening ideas, namely purpose, value proposition, risk of adopting, risk of rejecting, scope, type, stage,

communication strategy, resources, and participant roles. Through these empirically and theoretically grounded criteria, we illustrate the multifaceted nature of ideas. Thirdly, we create an IT artefact and thus provide a proof of concept by showing how an Idea Screening Framework (ISF) can be implemented and used in practice.

The remainder of this paper is structured as follows. We start by summarizing extant literature on intrapreneurship and idea screening. The research method section then offers detailed insights into the applied method and illustrates how both literature and insights from our empirical study informed the design of the Idea Screening Framework. In sections that follow, we describe in detail (1) what problem the Idea Screening Framework addresses, (2) what our proposed solution design looks like, and (3) how we implemented the Idea Screening Framework in an organization. We conclude with summarizing what lessons can be learned from the design and pointing to future research.

8.2 Related Work

Studies that informed our design are rooted in the fields of intrapreneurship and idea screening.

8.2.1 Intrapreneurship

Self-organizing networks of employees are a crucial driver for the development of complex and innovative digital technologies (Chesbrough, 2003). In an increasingly networked corporate environment, a differentiation strategy based on product, process, or business model innovation can be a key source of competitive advantage (Chesbrough, 2003; Tidd and Bessant, 2011). In this context, ever more companies purposefully use both inflows and outflows of knowledge to accelerate internal innovation and expand the market for external innovation (Chesbrough et al., 2005). This requires companies to replace centralized research and development (R&D) departments with more network-based work structures (Desouza, 2011, pp. 8–14). Whereas traditional R&D structures only enable selected experienced employees to work on ideas with a long-term impact, ever more companies facilitate collecting ideas from all sides (Neyer et al., 2009). Today's leading innovative companies encourage employees to act entrepreneurial within the confines of the organization, relying on its technical, financial, and professional resources (Desouza, 2011). Shrinking innovation

cycles and new digital technologies make innovation more networked and employee-driven (Robinson and Schroeder, 2014) and increase the need of understanding the larger societal and economic impacts of this new paradigm of innovation (Desouza, 2011; Høyrup et al., 2012). In this light, recent research foresees a paradigm shift from the stand-alone entrepreneur to increased networking and cooperation on a global scale (Dana and Wright, 2008). Intrapreneurship is a new form of direct participation in which the employee takes the initiative to generate, develop, and implement ideas for innovative products (Høyrup et al., 2012; Kesting and Ulhøi, 2010). Within every employee lies an innovative potential, which organizations need to foster and facilitate (Hargadon and Bechky, 2006; Kristiansen and Bloch-Poulsen, 2010). With the advent of modern information technologies, and the related ongoing digitalization of business processes in organizations, there is a growing interest in how information systems (IS) can enable intrapreneurship (Yoo et al., 2012). Closely related to this is the question how information systems can support the emergence and harnessing of knowledge networks (Etemad and Lee, 2003) and strengthen networking capabilities (Mort and Weerawardena, 2006). One prominent wicked problem in organizations that take intrapreneurship seriously is a surplus of ideas that exceeds the available resources to implement them. Thus, idea screening is an integral part of intrapreneurship that requires according facilitation support.

8.2.2 Idea Screening

Intrapreneurship offers new possibilities, but also poses new challenges to traditional ways of innovating in firms. This requires a revisit of established approaches for screening ideas. Classical approaches for realizing value from IT investments, such as IT portfolio management (Peppard and Ward, 2004) and benefits management (Peppard et al., 2007), are helpful for integrating new digital technologies into the corporate strategy in a way that envisaged benefits are achieved (outside-in). However, screening large amounts of ideas from different sources in a short time requires a radical rethink of received strategic frameworks to manage IT projects (Yoo et al., 2010). To cite a prominent case, the British Petroleum (BP) company placed a public call for ideas to contain the infamous oil spill resulting from the Deepwater Horizon disaster in 2010. During this period BP received more than 35,000 ideas. However, lacking a way to

quickly and accurately screen these ideas from diverse sources, frustration grew as BP seemed unable to select and implement solutions in time (Lindič et al., 2011).

More recently, innovation platforms gain momentum as a promising means to fund and realize ideas from a crowd of internet users (Mollick, 2014). However, it remains a challenge to integrate these approaches with innovation initiatives in a corporate context (Riedl et al., 2010; Schulze et al., 2012). For instance, a recent study among 313 participants of an innovation community found that popular simple idea screening mechanisms based on thumbs up/down or 5-star rating are invalid and outperformed by more fine-granular, multi-attributive idea screening mechanisms (Riedl et al., 2010). In line with this, a study argues that idea screening mechanisms purely based on numeric scores tend to be too restrictive to reflect the value of human intuition (Lindič et al., 2011). However, practitioners tend to prefer simple scales based on benefit and risk, often neglecting more complex approaches (Schönwälder, 2013). Although recent studies acknowledge the potential of IT to better capture the complexity of idea screening, we know little yet about effective designs in practice (Schulze et al., 2012).

Hence, we identify a research gap on how to provide comprehensive and multi-dimensional idea screening support for enabling intrapreneurship. Our goal with this paper is to (1) elicit the requirements of idea screening in the context of intrapreneurship and (2) propose an Online Idea Screening Framework that fits the according work practices of various stakeholders involved in intrapreneurship.

8.3 Research Method

Since our goal is to extend human and organizational innovation capabilities by creating a new artefact, this paper follows the design science research (DSR) in information systems (IS) paradigm (Hevner et al., 2004) and builds on the well-established DSR framework by Peffers et al. (Peffers et al., 2007). Hence, it is structured along six generic DSR activities: *1) problem identification, 2) objectives of a solution, 3) design & development, 4) demonstration, 5) evaluation, 6) communication*. Activities 1-5 are described in respective sections, and activity 6 is the paper's aim.

Initially, we identified the problem relevance and motivation for an Idea Screening Framework from a two-year interpretive field study (Klein and Myers, 1999; Walsham, 2006) of innovation practices at a multinational banking software provider. Relying on

the identified problem scenarios and the above described literature, we developed an initial prototype using the scenario-based development method (Rosson and Carroll, 2002). Next, we discussed the early prototype extensively in the research team and obtained feedback from key informants from practice, who viewed the addressed problem from various perspectives (Walsham, 2006). From these sessions, we obtained helpful feedback about different goals of managers and intrapreneurs with the system and were also able to develop and evaluate a working prototype. The following sections illustrate these steps in detail.

8.3.1 Case Presentation

Since the above described previous research suggests that idea screening is especially relevant in innovation processes that are employee-driven (Desouza, 2011), involve the confluence of ideas from various sources (Chesbrough et al., 2005), and deal with high degrees of complexity (Fichter, 2009), we selected the case based on three criteria: 1) high activity of intrapreneurship 2) high degree of collaboration and 3) high innovation complexity. This led us to the following company.

Banking and IT Solutions (BITS): Founded in the early 1990ies by a group of software engineers, the company rapidly grew to an international market leader in banking software. Until 2008's financial crisis increased the pressure to innovate and diversify its solution portfolio, the strategic focus of BITS was the development, distribution, and operation of its proprietary core banking system. The executive board became increasingly concerned that the product lifecycle of that system might have peaked, and initiated substantial investments in establishing an internal innovation management framework. In the following years, the strategic focus of BITS became the development of new products, services, and business models in collaboration with customers, external partners, and universities. Part of BITS' innovation strategy was a strong internationalization movement. In the last three years, the company grew steadily from around 600 to more than 2000 employees in two development centres and seven subsidiaries in Europe, Asia, and Australia. One of the goals of this study was thus to connect the innovation activities across the different locations.

8.3.2 Case Data Collection

As typical for a qualitative-interpretive field study, data collection and analysis proceeded in iterative-incremental cycles (Walsham, 2006). In the first data collection phase (02/2013 – 10/2013), the study focused on the way employees communicate ideas across intersecting social worlds. The first author spent between 2-4 days a week onsite at the BITS headquarter and had access to an in-house workstation and intranet platforms. From there, the author conducted 32 semi-structured interviews to get an in-depth understanding of the focal phenomenon from a participant's perspective (Miles and Huberman, 1994). Executives provided an initial set of interview partners and we proceeded with selecting participants with innovation experience via snowball sampling, through the network of personal contacts (Stebbins, 2001, p. 200). Questions addressed the participants' innovation practices when collaboratively developing ideas, whereat participants were required to use authentic examples of their own experience. In doing so, we could document in detail the information requirements of various stakeholders throughout the innovation process. The phase ended with writing an interim study report with a status quo analysis, which we discussed with BITS to inform about our findings and frame the next phase.

In the second data collection phase (01/2014 – 12/2014), the study focused on how BITS employees collaborate across geographically distributed locations. The first author continued to spend between 1-2 days a week onsite at the BITS headquarter, and additionally spent between a week in a row onsite at a remote subsidiary of BITS, during which he interviewed additional 30 experts. Questions addressed the way employees organize and share information about their innovative ideas. We thoroughly analyzed online networking platforms regarding their actual and potential usage for innovation and elaborated a set of key use cases. Using multiple sources of evidence (Walsham, 2006) and triangulating between 1) the primary data from the interviews, and 2) the collected secondary data we extracted from these platforms, we were able to draw a more detailed picture of the actual innovation practices. The second phase ended with a report of an early concept of the Idea Screening Framework that we discussed with BITS representatives to identify concrete actions to take in the next phase.

In the third data collection phase (from 01/2015-12/2015), we developed an IT artefact as proof-of-concept and deployed it in BITS' intranet. The IT artefact instantiates the previously defined Idea Screening Framework. We conducted several user test workshops with BITS employees and managers to evaluate the artefact's usefulness. Furthermore, we conducted 4 additional interviews with key users to obtain in-depth feedback on the prototype. Table 1 provides an overview of the data collection.

Table 8-1 : Overview of Data Collection

Data Source	1st Phase (02/2013–10/2013)	2nd Phase (01/2014–12/2014)	3rd Phase (01/2015–12/2015)	Total
Interviews	32 Interviews	30 Interviews	4 Interviews	66 Interviews Total=3824min (Average=57.94, min=19, max=100)
Documents	216 Documents	202 Documents		418 documents - E.g. project documents, wiki pages, online platform content, archival data
Participant Observation	113 Days onsite	50 Days onsite	33 Days onsite	196 days spent onsite the case companies - Attending formal project meetings, workshops, presentations, and maintaining informal contacts - Giving talks, organizing workshops and steering meetings, collaborating with project teams

8.3.3 Case Data Analysis

We carried out the data analysis collaboratively relying mostly on interview transcripts, collected documentary material, and field reports. We met in a group of four researchers in weekly focus groups (Krueger, 2009) to maintain a critical distance with the case company (Wickson et al., 2006). The interviews were recorded, transcribed, and processed using MAXQDA, where two researchers developed a codebook to facilitate joint analysis and increase confidence in the findings (DeCuir-Gunby et al., 2011). Two additional researchers carried out coding checks to ensure intercoder reliability and develop a shared conception of reflection (Weston et al., 2001), through which we identified problem scenarios and solution objectives. We analyzed the

interview data leveraging methods borrowed from grounded theory methodology, engaging in open, axial, and selective coding to identify key issues and the relationship between them (Corbin and Strauss, 1990).

8.3.4 Structured Literature Analysis

Parallel to the case data collection cycles, we conducted a structured literature analysis in which we followed the well-established framework by Vom Brocke et al. (vom Brocke et al., 2009). Hence, we conducted the five generic steps: *1) definition of review scope 2) conceptualization of topic 3) literature search 4) literature analysis and synthesis 5) research agenda*. Steps 1-2 followed from the field study in which we identified research topics and the scope, namely idea screening in intrapreneurship. In step 3 we searched on Google Scholar and AIS electronic library for the keywords "digital-, employee-driven, and open innovation, innovation management, -practices, and -roles, idea screening, -evaluation, -selection, -assessment, and -tracking, balanced scorecard", selected 73 sources from reading the titles and abstracts, and synthesized the selected sources into an early version of the here presented Idea Screening Framework (step 4). We then framed the research agenda (step 5) by moving back and forth between data and literature, interrogating field material to check whether the data supported emerging claims, and whether literature helped us making sense of the empirics (Yanow and Schwartz-Shea, 2013).

8.4 Problem Identification and Solution Objective

In this section, we illustrate in detail the problem understanding we obtained from the empirical study and illustrate the information requirements for the various stakeholders of the innovation process. The problem scenarios are stylized cases of observed recurring problems at the case company (Rosson and Carroll, 2002).

Problem Scenario 1: Intrapreneur Wants to Realize an Idea

Malcolm, a 25-year-old recent university graduate and junior software engineer at BITS, recently had an idea for a mobile banking application for smart watches. He quickly sketches a few screens and discusses them with colleagues during a coffee break. Malcolm's colleagues are excited about the idea, but he is still unsure about its feasibility, since BITS does not have any experience with smart watch applications yet. Also, Malcolm does not have a well-established network in the company yet, so he asks his line manager for advice. The line manager is currently quite busy and tells Malcolm to ask Denis, an experienced business analyst, who has promoted a lot of ideas in the past. A bit doubtful, Malcolm reveals the idea to Denis, who generally likes it, but emphasizes the importance of elaborating a business plan, to see how the company can make money with the idea. Malcolm has never created a business plan, but is motivated to invest two weeks of his spare time and a lot of help from his peers to write one. Afterwards, Denis sends the business plan to Corinne, an innovation manager at BITS. Corinne knows by chance that another team already develops a prototype for such an application, which is very similar to Malcolm's idea. Malcolm is very frustrated to have spent that much effort in vain."

The key issues with this problem scenario are the following:

1. *Lack of Transparency about Innovation Process:* Although many companies employ a formal innovation process, intrapreneurs often do not fully understand the decision structures behind the innovation process of the company and lack an overview over existing ideas (Fichter, 2009). As a result, they need to invest substantial time in building a social coalition for their idea, which is difficult because different stakeholders have different information requirements, and they often lack the social capital to persuade advocates and sponsors (Desouza, 2011).
2. *Lack of Guidance:* Intrapreneurs further need guidance and orientation to ensure completeness and consistency of relevant criteria, and to ensure that all relevant stakeholders are involved. Recent research on organizational innovation indicates that a complex network of people with different roles support innovation processes, and that catalysts or facilitators might be equally important as intrapreneurs (Tortoriello et al., 2014).

Problem Scenario 2: The Innovation Board Selects Ideas for Funding

Corinne, a 38-year-old now innovation manager and former product manager at BITS, organizes a meeting with the innovation board, a committee of experienced employees, in order to decide which ideas should receive funding. She also invites the employees to present their business plans. Some presentations are very technical, and the innovation board has a hard time fully understanding the idea and assessing the benefits and risks. This makes the evaluation very demanding. Some of the ideas are presented with the help of an elaborated prototype. In these cases, the ideas are more comprehensible, but deciding to not fund these ideas is even harder for Corinne, because she knows that already a lot of work was invested in the idea. Many of the presented ideas look promising to her, but she knows that they can fund only few of them because most of them do not fit into the strategy of the company. Moreover, the resources they can allocate are limited, because this year's strategy is to focus on implementing customer requirements. They must rely on intuition to evaluate the ideas, as fully evaluating all ideas in these different representations would be too demanding and time consuming.

The key issues with this problem scenario are the following:

1. *Complexity of Idea Screening*: There is often an abundance of ideas existing in a company (Chesbrough et al., 2005; Gorschek et al., 2010), and therefore idea screening is a time consuming and cognitively demanding task. Given that ideas are often hard to compare with each other (Desouza, 2011), it is very complex to assess the potential value of an individual idea (Jouret, 2009),
2. *Lack of (Reasonable) Decision Criteria for Evaluating Ideas:* Companies are often held captive by customer requirements which consumes innovation resources (Christensen, 1997), because most funding decisions are based on financial aspects. One drawback of screening models purely based on numeric scores is that they tend to be too rigid and neglect human reflection and experience (Riedl et al., 2010).

Problem Scenario 3: Innovation Manager Wants to Track Ideas

Corinne has her monthly status meeting with the CEO. The CEO just came back from an IS conference and was intrigued by a talk about crypto currencies. She is convinced that crypto currencies will soon become a disruptive innovation in the banking industry, so she asks Corinne whether there already exist any related ideas in BITS. Corinne must acknowledge that she does not know. She has only recently taken over this position after the former innovation manager left the company. There is no idea repository and Corinne must now ask all responsible intrapreneurs for the status of all innovation projects she inherited. The intrapreneurs themselves are not satisfied with having to start explaining their ideas anew and often give Corinne snippy responses. Both the CEO and Corinne are frustrated that even the innovation management does not seem to know about all ideas within the company.

The key issues with this problem scenario are the following:

1. *Lacking Overview of Existing Ideas*: It is very difficult to have an aggregated view over existing ideas (Desouza, 2011) in order to detect strengths and weaknesses in the innovation process and compare the innovativeness of the company with other organizations (Desouza, 2011). After all, trends in technology are difficult to anticipate, as any innovation involves some degree of uncertainty (Jalonen and Lehtonen, 2011).

From these problem statements, we identify that the *solution objective* of an Idea Screening Framework is to facilitate the evaluation, selection, and tracking of ideas in an organization. The Idea Screening Framework should on the one hand give intrapreneurs guidance through the innovation process by evaluating, selecting, and tracking ideas. Through a central idea repository, intrapreneurs should be able to evaluate ideas by submitting them in a semi-structured manner, focus on relevant criteria, find relevant experts, and obtain community feedback. Through this idea repository, intrapreneurs should also be able to select relevant ideas from a large pool and, thereby, get an overview and orientation of the existing innovation process. Entries in the idea repository should enable the intrapreneur to track the status of his/her idea.

On the other hand, the Idea Screening Framework should also allow managers to evaluate, select, and track ideas to make informed decisions of innovation projects within the organization. Through an aggregated overview of the innovation process, managers should be able to detect weaknesses and strengths by evaluating ideas in different stages, and make micro and macro level analyses of ideas. Through a semi-

structured set of criteria, managers should be able to compare ideas against each other and select the most promising ones for further funding. Again, entries in the idea repository should enable managers to track the status of ideas.

To conclude, the Idea Screening Framework should provide enough structure to adequately illustrate decision-relevant information for managers at the right level of detail and abstraction, but at the same time provide intrapreneurs with enough flexibility to allow for sufficient interpretive openness and ambiguity that matches creative ideas. If the framework was too rigid it would prevent complex ideas to emerge and only serve few managers for decision support (Desouza, 2011), but intrapreneurs would not feed the system with the necessary data. However, if the framework was too loose, the process would become arbitrarily complex, ideas could not be compared with each other, and managers would not take the system seriously. Hence the Idea Screening Framework should fulfil the requirements of a boundary object and be both flexible and robust to develop a common understanding and maintain coherence across intersecting social worlds (Star and Griesemer, 1989).

8.5 Artefact Design and Development

So far, we motivated the need for an Idea Screening Framework by illustrating the problem, along with its significance, and envisaging how a better solution could look like. In this section, we describe in detail the concepts behind the Idea Screening Framework and the functionality of the IT artefact we implemented.

8.5.1 Criteria

Our literature and empirical analysis yielded the following criteria that are important for screening ideas: *Purpose, Value Proposition, Risk of Adopting, Risk of Rejecting, Scope, Type, Stage, Communication Strategy, Resources, and Participant Roles*. As shown in figure 1, these can be grouped into three categories.

Strategic criteria are mostly important for executives to make strategic decisions whether the idea should be pursued. For this, it is necessary to make assumptions about the benefit (which is incorporated in the Purpose and Value Proposition criterion) and risk of the idea. This is also important for potential collaborators, and customers to have a precise definition of the idea's core selling point. *Tactical criteria* are mostly important for the idea owners and innovation managers to have an overview about the status and

next steps of an idea or all managed ideas. *Operational criteria* are especially helpful for facilitators and the intrapreneurs themselves to carry the idea further step by step.

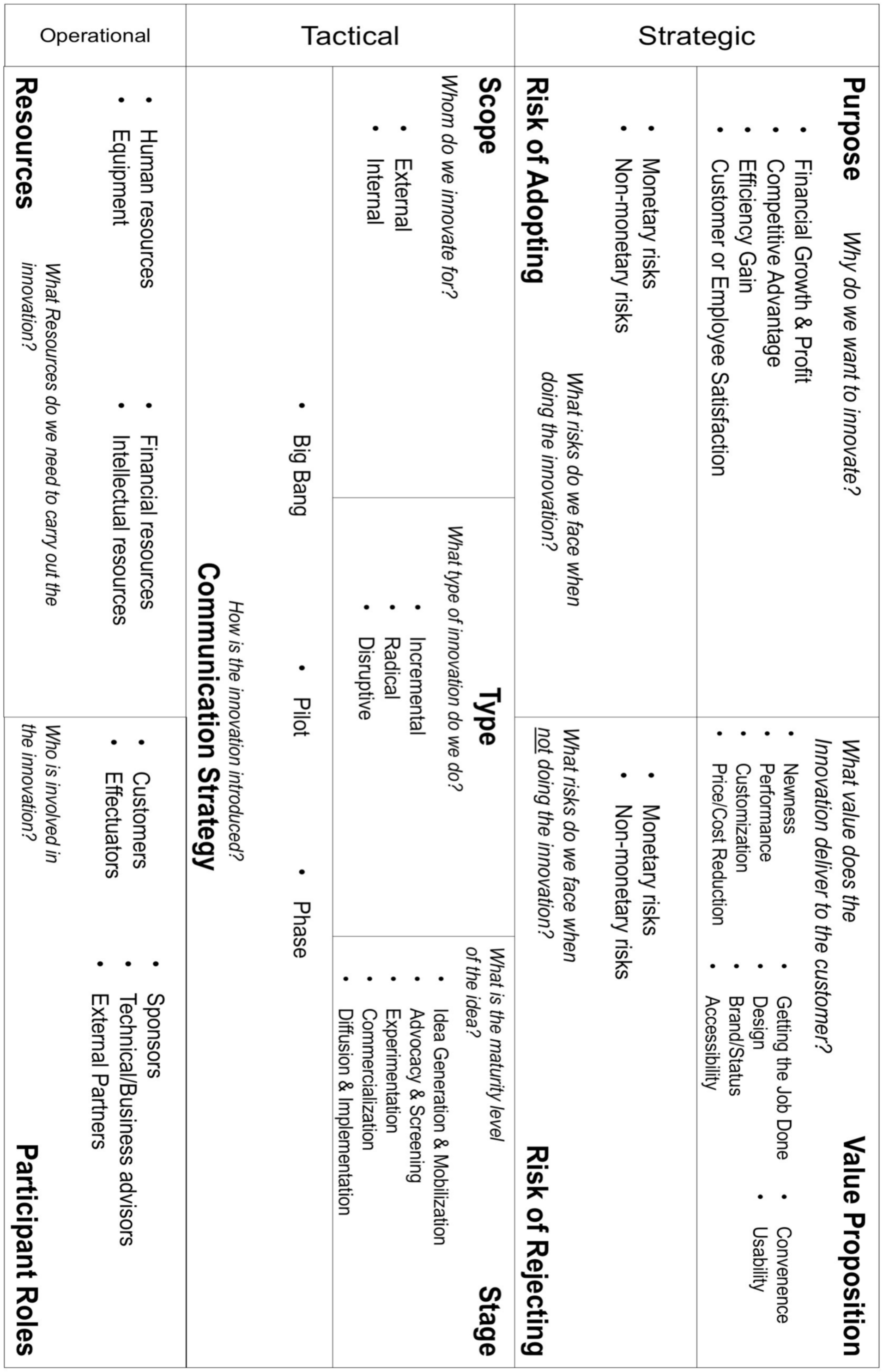

Figure 8-1 : Overview of Criteria in the Idea Screening Framework

Purpose (why do we want to innovate?): Defining the purpose of an innovation helps to better understand the direction in which we are moving and the kind of benefits we can expect from moving into that direction. It facilitates the creation and recognition of links between the organizational strategy and the idea (Gama et al., 2007). Ultimately, any IT innovation should create a clear business benefit.

The different reasons to innovate identified during our research can be encompassed by four different attributes. *Financial Growth & Profit* aims at increasing revenue or market share, winning new customers, selling more products or licenses, or entering new markets (Christensen, 1997). One interviewee stated "it would be more interesting to make money from this innovation. That would be my main goal." *Competitive Advantage* aims at putting the organization ahead of competitors or preventing it from falling behind, for instance through achieving knowledge leadership, providing distinctive quality, or gaining the agility to profit from new opportunities (Tidd and Bessant, 2011). One interviewee stated "if you have a complicated IT architecture, then your ability to move is like having lead weights on your feet". *Efficiency Gain* aims at doing the existing business faster and with fewer resources than now, for instance through improving communication efficiency, reducing delivery time, and increasing the input/output production ratio. *Customer or employee satisfaction* has the purpose to increase the satisfaction provided to end users, whether they are inside or outside the organization (Desouza, 2011). Such innovations contribute to the creation of a compelling place to work and deal with sources of customer frustration.

Value Proposition (what value does the innovation deliver to the customer?): This criterion helps to identify the benefits that the innovation brings to the customer, and implicitly, the customer problems and needs that the innovation satisfies. This is important for the customer to determine whether to do business with the company. The attributes of this criterion are derived from the business model canvas (Osterwalder and Pigneur, 2010).

Newness satisfies a new set of needs the customer did not perceive before. For instance, these days' smart watches may fall into this category. *Performance* improves the perceived usefulness of the existing features of a product or service. *Customization* adapts a product or service to the specific needs of the customer, such as customized or co-created products. *Getting the job done* means that the value resides simply in helping

customers to accomplish their goals by providing a platform so they can run their business according to their needs. *Design* offers an outstanding and appealing design and creates value through aesthetics and ease of use. *Brand/Status* provides value by association with a specific brand with a certain social status. *Price* provides value through offering similar value than competitors, but at lower cost. *Cost Reduction* helps customers to reduce their cost, e.g. through self-service systems. *Risk reduction* reduces the risk of doing business, for instance through IT audits. *Accessibility* provides value by making the product accessible to customers who previously did not have access. *Convenience/Usability* provides value by making a product or service more convenient or easier to use, such as mobile banking apps.

Risks of Adopting (what risks do we face when doing the innovation?): This criterion refers to how the changes produced by the adoption of an innovation could negatively influence the organization and its environment. This is relevant for screening ideas because it helps to explore the scenarios that could result from adopting the innovation (Rogers, 2010).

Monetary risks are financial risks of adopting the innovation. For instance, the needed resources may exceed the planned available resources due to poor project management or unforeseen factors such as changing requirements. *Non-monetary risks* cannot be measured in financial figures. For example, changes induced by the innovation may negatively impact some of the stakeholders, or the company may become dependent on a used technology and face lock-in effects.

Risks of Rejecting (what risks do we face when not doing the innovation?): This criterion refers to how the rejection of an innovation could affect the organization and its environment. This is relevant for screening ideas because it helps to explore the scenarios that could result from not innovating (Rogers, 2010). *Monetary risks* are financial risks of rejecting the innovation. For instance, the organization may miss potential profits (opportunity cost), or even have to pay fees and penalties when falling behind regulatory requirements. *Non-monetary risks* are risks of rejecting the innovation that cannot measured in financial figures, such as falling behind a competitor or negative reputation that results from being an innovation laggard (Rogers, 2010).

Scope (whom do we innovate for?): This criterion refers to the target group of the innovation endeavours, which can either be internal or external (Chesbrough, 2003).

This criterion can provide awareness about the balance of the innovation efforts made by the organization internally and externally. *External* innovations would encompass all products, processes, and services developed for customers outside the organization; while *internal* innovations comprise the innovations developed to be used within the organization.

Type (what type of innovation do we do?): Considering the type of innovation is important because different types of innovation require different managerial approaches (Trauffler, 2005). Recognizing and selecting the correct approach is vital for the success of the idea. *Incremental innovation* describes smaller incremental improvements on existing products, processes, or business models. *Radical innovation* refers to the creation of breakthrough products, processes, or business models with novel and unique characteristics, which often leads to a complete replacement of the previous working model (Stringer, 2000). *Disruptive innovation* encompasses those innovations that transform a product or service in a way that the market does not expect, usually aiming at a new group of consumers. This may involve the downgrading of the product to make it more accessible to customers that would not have afforded it otherwise. For instance, Henry Ford created a disruptive innovation when he took the existing idea of luxurious handcrafted cars which where only accessible to the higher class, and created factory made cheap generic automobiles accessible to the middle class (Christensen and Raynor, 2003). It is important to note that here, the type of innovation, reflects the inner view of the organization (i.e. is the innovation incremental, radical, or disruptive for the organization), not the market view.

Stage (what is the maturity level of the idea?): Awareness about the maturity level of the ideas is important because it helps to identify what has already been done, what tasks are currently important, and what are the next steps. Identifying the stages of the innovation process is necessary for proper idea screening (Lindič et al., 2011). A five stage innovation process described by Desouza (Desouza, 2011) serves as a base for this criterion. The process starts with the *Idea Generation & Mobilization* stage, where novel ideas are brainstormed from the daily business and informally set in motion, before they become discussable projects competing for funding in the *Advocating & Screening* stage. Here, idea owners advocate for the idea and build social coalitions, while managers are concerned with allocating resources to the most promising ideas. The

funnel gradually narrows down in the *Experimentation* stage where intrapreneurs explore solution possibilities and constrain the possible solution stage by creating prototypes. Afterwards, the organization is concerned with turning the idea from concept to solution and developing a marketing plan in the *Commercialization* stage. Eventually, in the *Diffusion and Implementation* stage the company seeks to push the idea to the farthest corners of the market and show customers how to use the new product or service successfully.

Communication Strategy (how is the innovation introduced?): This criterion covers the way the idea is implemented in the target organization. Not all ideas are introduced to the world in the same manner, and the way we introduce a new idea may have a significant impact on its subsequent success. This success depends on different factors such as resistance caused by attachment to existing tools, learning curves, or perceived low value provided to individual adopters in the beginning that only increases with the size of the adoption network (Fichman, 2004). Awareness of this Criterion can help to determine if and how an idea should be implemented at a given moment (Eason, 2005).

A *Big Bang* communication strategy introduces the innovation to the world all at once. A *Pilot* communication strategy introduces the idea at small scale to evaluate its performance before introducing it at full scale. The pilot is tested by a small group of users at first, and the innovation is released to the world after evaluating its success. A *Phase* communication strategy introduces the innovation to the world in phases, each phase taking place at a different time. Only the current phase of the idea is communicated to the world, but not the next steps.

Resources (what resources do we need to carry out the innovation?): This criterion is important for screening ideas because feasibility analyses prior to taking ideas forward are crucial. Not considering technical, financial, market, and human resource aspects before starting to realize an idea could result in project failure or serious losses. A good understanding of the innovation capabilities of the organization is crucial to determine which ideas it can realize and which ones it simply cannot afford (Christensen and Raynor, 2003). The attributes of this criterion are extracted from (Christensen, 1997). *Human resources* refer to manpower required for carrying out the innovation, typically the number of project team members. *Equipment* refers to physical or digital instruments required for carrying out the innovation, such as IT equipment

(hardware or software), building infrastructure, tools, or vehicles. *Financial resources* refer to the budget that is necessary to carry out the innovation, such as initial investment. *Intellectual resources* refer to know how that is necessary to carry out the innovation, such as technical, organizational, or business knowledge.

Participant Roles (who is involved in the innovation?): Several studies focus on the identification and categorization of different roles relevant for innovation (Chakrabarti and Hauschildt, 1989; Meyer, 2000). Some authors use the roles of idea generator, idea champion, orchestrator, and devil's advocate (Meyer, 2000), while others define the roles as product champion, gatekeeper, sponsor, business innovator, technical innovator, and promoter (Chakrabarti and Hauschildt, 1989). Our study also revealed the importance of different stakeholder roles in the innovation process at BITS, and we consolidated these findings with the literature to derive the following six attributes in which the participant roles fall.

Customers are clients involved in the innovation process, such as clients giving input for an idea are acting as a source of ideas. *Effectuators* take ownership of an idea and are the ones who are in charge of carrying the idea through the different innovation process phases (Sarasvathy, 2001). They advocate for the idea, request funding, and are involved in the development of the idea. *Technical advisors* possess technical expertise in the relevant field and provide detailed technical information and advice about the idea, for example about the technical feasibility of the idea or appropriate technologies to realize it (Chakrabarti and Hauschildt, 1989). *Business advisors* possess more deep knowledge on the business aspects around the idea, know the customer or the market well, and thereby provide financial or strategic advice for turning the idea into a profitable solution (Chakrabarti and Hauschildt, 1989). *External partners* are collaborators from outside the organization that are involved in realizing the idea, such as technology partners, implementation partners, or training partners (Tidd and Bessant, 2011). *Sponsors*, such as innovation boards, incubator companies, or venture capitalists (Chakrabarti and Hauschildt, 1989), can provide the financial resources that are necessary to carry out the idea.

8.5.2 IT Artefact

We built the Idea Screening Framework as web application. The artefact functions as a plug-in for the BITS intranet, which means that employees could already use and test

the system. The workflow is structured as follows. Whenever a new idea emerges, the idea owner can add a new idea with a title, a short description, and keywords. At this stage, the idea automatically has the *Stage* value "idea generation and mobilization" and the other criteria are optional fields. The idea owner can choose whether the idea is private to some users or publicly displayed and the system suggests some experts for the *Participant Roles* criterion based on entered keywords. Users can then comment and rate the idea. If the idea owner wants to further pursue the idea, he sends a request for promotion to the "advocacy and screening" *Stage*. An idea evaluator, who is typically an innovation manager, then assesses the idea in an innovation board meeting. Here, the criteria *Purpose, Value Proposition, Scope,* and *Type* are mandatory fields that guide the evaluation, whereat the idea evaluators can either fill in the values themselves or request further information from the idea owner. After this activity, the idea evaluators decide on whether to accept or reject the idea at this stage of the process. If the idea is accepted, the idea owner can further refine the idea and elaborate especially in the *Resources* and *Participant Roles* criteria, which are now mandatory at this stage of the process. Here, the Idea Screening Framework guides the idea owner with clearly formulating the necessary criteria for a business plan. The idea owner can then send another request to the idea evaluator for promoting the idea to the "experimentation" *Stage*. In this case, the idea evaluator makes another assessment of the idea based on the criteria *Participant Roles*, *Resources, Risk of Adopting*, and *Risk of Rejecting* and decides in an executive board meeting on whether and how many resources to allocate for "experimentation". The idea owner can now publish information regarding the idea on the idea page and discuss issues with facilitators. This also allows idea evaluators to track progress and generates useful documentation for marketing & sales personnel when the idea proceeds to the "commercialization" *Stage* and a marketing plan needs to be developed. Modifications are historicized to facilitate back tracking of an idea's development. Through this iterative workflow, the IT Artefact limits the complexity of the Idea Screening Framework. BITS representatives gave positive feedback for this aspect in the evaluation workshops.

8.6 Artefact Demonstration and Evaluation

We demonstrated the artefact in several workshops with experts at BITS. This helped us to validate the Idea Screening Framework's usefulness and usability, and to refine its criteria or include additional ones. For instance, managers would point to the need for better classification of the risk criterion, including parameters that reflect the degree of intensity (e.g. low, medium, high), or further distinguishing the financial figures. Additionally, we conducted proof-of-concept workshops where we used a printed version of the Idea Screening Framework to categorize 10 existing ideas that were in progress at BITS at that time. Afterwards we implemented a click through prototype to test how users would react to the system. The test users were very satisfied with the functionality to select from large amounts of ideas, compare them against each other, and make an aggregated macro level analysis of all ideas in the different innovation process phases. Since the initial flat representation of the Idea Screening Framework was perceived as complex, we grouped the criteria into categories (strategic, tactical, operational).

This paper reports on a prototype implementation. The complete implementation and evaluation of the system will be subject of future work. We propose to evaluate the Idea Screening Framework against the above described problem scenarios. In various workshops, we interviewed participants whether the prototype would be useful and usable to improve the described problems, confirming that the idea screening criteria were valid and complete. In these workshops, it came evident that the Idea Screening Framework needs to find the right degree of complexity to allow different stakeholders express their different views in the system. The criteria for a qualitative evaluation of the system are average time required for screening an idea, number of ideas being experimented on, cost and revenues of ideas, number of implemented and diffused ideas, quality of ideas, most competent intrapreneurs and reviewers, and satisfaction with the system when screening ideas.

8.7 Implications

These days, the global business environment changes dramatically due to lowered technological and organizational entry barriers. Small and medium-sized enterprises (SMEs) are now able to compete globally with large incumbent firms through lowered

transaction cost and increased scalability afforded by advanced information technologies. Entrepreneurial SMEs contribute substantially to economic growth and innovation, posing new opportunities but also new challenges to management strategies. In line with this, recent research indicates a shift from the stand-alone entrepreneur to increased networking and cooperation, resulting in an internationalization that leads to a decentralization of control (Dana and Wright, 2008). With the increased networking and internationalization of innovation activities within and across organizations, intrapreneurship gains in importance (Desouza, 2011). However, the potential of information systems to support innovation practices in the context of intrapreneurship is not yet fully understood. The present study responds to these trends by providing an Idea Screening Framework and showing with a prototype implementation how it can enable intrapreneurship.

One important implication is that information systems can support the evaluation, selection and tracking of ideas in intrapreneurship if, and only if, they provide a robust yet flexible structure for screening ideas. Organizing ideas for easy evaluation, selection, and tracking requires a taxonomy that classifies ideas by decision-relevant criteria (Desouza, 2011). The here proposed Idea Screening Framework provides a set of ten such criteria that are grounded in empirical data from a field study and related literature. This criteria catalogue provides a useful starting point for the standardization of idea screening in intrapreneurship. SMEs adopting the here proposed Idea Screening Framework will be better able to evaluate, select, and track ideas. This includes comparing different types of ideas with each other, assessing the innovativeness of one organizational unit against that of another, facilitating better knowledge exchange across organizational boundaries, enhancing networking capabilities, and providing an aggregated overview of available resources.

Moreover, our provided IT artefact demonstrates how the Idea Screening Framework can facilitate the emergence of knowledge networks in an internationalization context. The nature of the entrepreneurial discovery currently changes dramatically from developing ad-hoc solutions for a problem at hand to identifying and accessing readily available solutions residing in existing knowledge networks (Etemad and Lee, 2003). Information systems can support this development by tracing and documenting knowledge in a readily accessible format. The here suggested criteria catalogue also

allows for standardization of the elicitation of decision-relevant information about the idea. This facilitates easy accumulation and retrieval of knowledge across organizational boundaries and thereby expands the networking capabilities of intrapreneurs. These networking capabilities enable identification of business opportunities and facilitate the development of knowledge-intensive products on an international scale (Mort and Weerawardena, 2006). By having an IT-based Idea Screening Framework in place, companies can facilitate easier information exchange about ideas internally and externally.

From this, we derive the following practical recommendations for enabling intrapreneurship:

Implement an Idea Screening Framework: Organizations should have an ISF in place to facilitate the structured evaluation, selection, and tracking of ideas. Intrapreneurs need guidance and orientation during the development of ideas, while managers need an overview and reasonable decision-relevant criteria for the evaluation of ideas. The here proposed ISF provides an initial solution that may be tailored to the specific needs of the organization.

Communicate the Benefits of Idea Screening: An ISF is a servant of two masters in need to fulfil the dual role of supporting intrapreneurial and managerial practices simultaneously. These different stakeholder groups have different and sometimes conflicting interests in idea screening. Thus, it is important to clearly communicate the benefits of the ISF for all stakeholder groups, for instance via workshops, video tutorials, evangelists, manuals, and coaching.

Implement Performance Metrics for Idea Screening: Implementing performance metrics is a helpful way to ensure that the benefits of the ISF are met. These performance metrics can further increase transparency of ongoing innovation activities and should thus be easily accessible for both intrapreneurs and managers. We recommend to establish the following performance metrics: Average time required for screening an idea, number of ideas being experimented on, cost and revenues of ideas, number of implemented and diffused ideas, quality of ideas, most competent intrapreneurs and reviewers, and satisfaction with the system when screening ideas.

Prepare for External Collaborators: One positive side-effect of establishing an ISF is that ideas can be easier shared across organizational boundaries. This may also support

intrapreneurship in that collaboration with external partners becomes easier. In this sense, the ISF may also contribute to new internationalization opportunities for SMEs by forming alliances with networks of other companies (Dana et al., 2001).

8.8 Conclusions and Outlook

As intrapreneurship becomes more widespread, appropriate screening of large amounts of ideas becomes more crucial for firms. Organizations tend to generate more ideas than they can actually implement, and these ideas compete against each other for resources (Andrew et al., 2010; Desouza, 2011). Against this backdrop, idea screening should not only be seen as a single phase of the innovation process, but rather as something that should be considered throughout the whole process. However, extant screening procedures are either too unstructured to facilitate evaluation, selection, and tracking, or too structured to capture complex ideas (Riedl et al., 2010).

In this paper, we propose an Idea Screening Framework and demonstrate how it can support the evaluation, selection, and tracking of ideas, which are crucial for intrapreneurship. Our key design lesson learnt is that an information system that supports idea screening needs to be a servant of two masters. On one hand, it needs to provide decision support by illustrating the relevant information for deciders in the right level of abstraction. In that regard, the Idea Screening Framework needs to be a precise model of an idea that provides unambiguous decision-relevant information. But at the same time, the Idea Screening Framework needs to provide a sufficient level of ambiguity to allow for interpretive flexibility and serve as boundary object across intersecting social worlds (Star and Griesemer, 1989). We contribute to extant literature by illustrating the dual role of idea screening and putting it into the work context of intrapreneurship.

Companies may implement this Idea Screening Framework and customize the specified criteria and attributes according to their specific needs. For instance, a company could configure the bounds of what constitutes a high financial profit or where the line between high and medium risk lies, and specify the available participant roles.

This paper reports on our experience from implementing a prototype Idea Screening Framework within one organization. While the preliminary evaluation of the ISF shows

great potential to enable intrapreneurship, it would be interesting to test whether the here proposed design is useful in other kinds of organizations, too.

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8.9 References

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